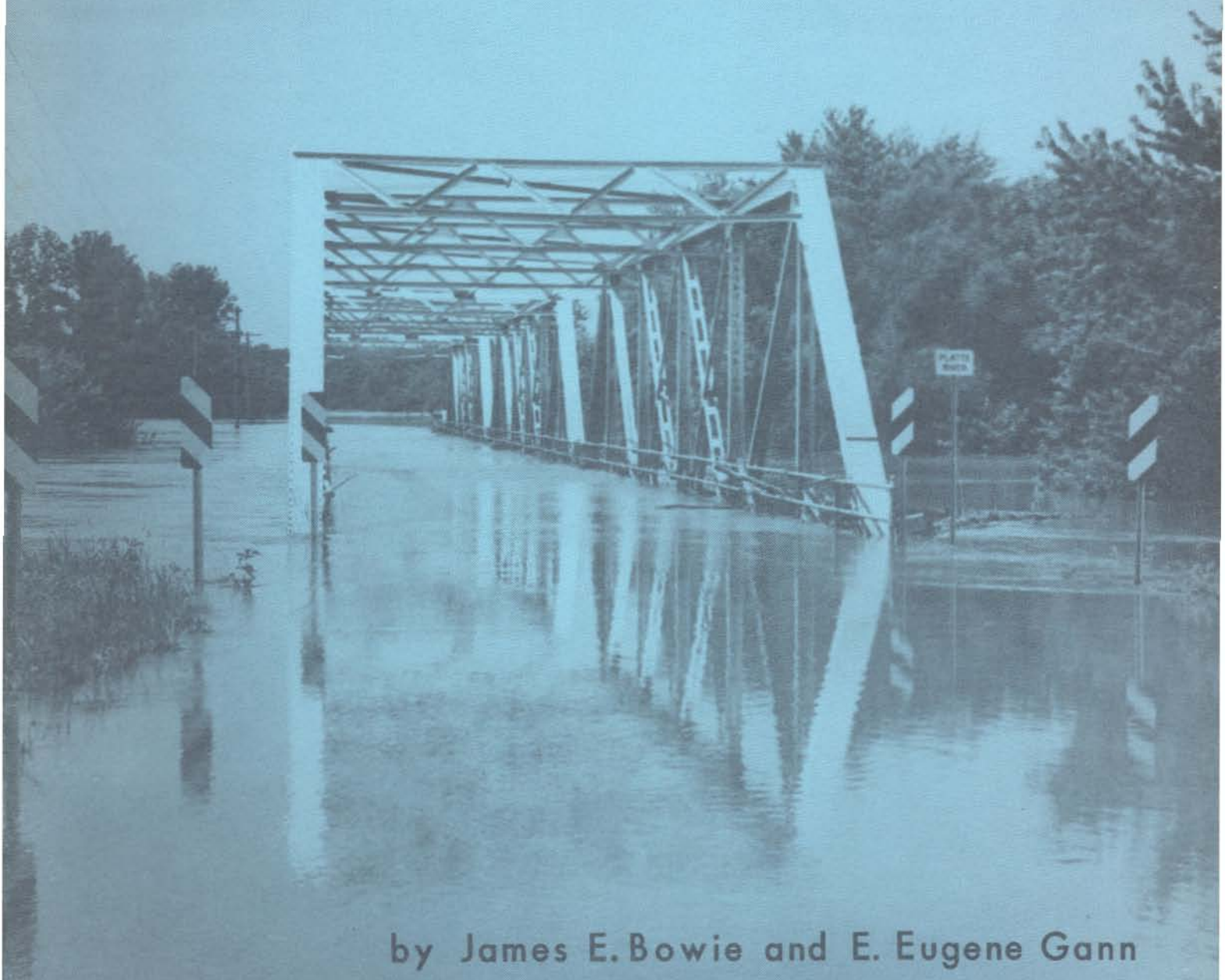


FLOODS of July 18-23, 1965 in Northwestern Missouri



by James E. Bowie and E. Eugene Gann

WATER RESOURCES
REPORT 21

Floods of July 18-23, 1965 in
Northwestern Missouri

by

James E. Bowie

and

E. Eugene Gann

Hydraulic Engineers
U. S. Geological Survey, Water Resources Division

Prepared in cooperation

with the

Missouri Geological Survey and Water Resources
Missouri State Highway Commission
Corps of Engineers, Department of the Army
Environmental Science Services Administration, Weather Bureau

Rolla, Missouri

December 1967

STATE OF MISSOURI
Warren E. Hearnese, Governor

DEPARTMENT OF BUSINESS AND ADMINISTRATION
Mrs. Ruby Jane Happy, Director

DIVISION OF GEOLOGICAL SURVEY AND WATER RESOURCES
William C. Hayes*, Ph. D., State Geologist and Director
Wallace B. Howe*, Ph. D., Assistant State Geologist

STRATIGRAPHY

Larry D. Fellows, Ph. D.,
Chief, Stratigraphy Section
Thomas L. Thompson, Ph. D., Geologist
Ira R. Satterfield, M. S., Geologist
Karen S. Maroon, Clerk Typist II

GROUND WATER

Dale L. Fuller, B. S.,
Chief, Groundwater Section
Robert D. Knight*, B. S., Geologist
Albert E. Koch, Clerk III
Glenda M. Otis, Clerk Typist II

SUBSURFACE GEOLOGY

Kenneth H. Anderson, B. S.,
Chief, Subsurface Section
Jack S. Wells, B. S., Geologist
Henry M. Groves, B. S., Geologist
Arthur W. Hebrank, B. S., Geologist
Linda J. Stukey, Clerk Typist II
Alleene N. Brooks, Clerk Typist II
Woodrow E. Sands, Laboratory Supervisor
Ira F. Bowen, Laboratory Technician
Jerry A. Plake, Laboratory Assistant

GEOLOGICAL RESEARCH

Mary McCracken, B. S., Research Geologist
Richard E. Wagner, E. M., Research
Geologist

PUBLICATIONS AND INFORMATION

Jerry D. Vineyard*, M. A., Geologist
Kittie L. Hale, Clerk III
Oma E. Carnahan, Clerk Typist II

ECONOMIC GEOLOGY

James A. Martin*, M. S.,
Chief, Economic Geology Section
Heyward M. Wharton, M. A., Geologist
Eva B. Kisvarsanyi, M. S., Geologist
Charles E. Robertson, M. A., Geologist

GRAPHICS

Douglas R. Stark, Chief Draftsman
James L. Matlock, Draftsman

ANALYTICAL CHEMISTRY

Mabel E. Phillips, B. S., Chemist

ENGINEERING GEOLOGY

James H. Williams*, M. A.,
Chief, Engineering Geology Section
Edwin E. Lutzen*, M. A., Geologist
Christine L. Jacobs, Stenographer II

ADMINISTRATION AND MAINTENANCE

Charlotte L. Sands, Administrative
Secretary
Edith E. Hensley, Accountant-Clerk III
Jean A. Fitzgerald, Stenographer II
Everett Walker, Supt., Bldg. & Grounds
Wilbert P. Malone, Maintenance Man I
Walter C. Bruss, Custodial Worker I

LIBRARY

Bonnie L. Happel, Librarian
Judith A. Schiffner, Clerk Typist II

COOPERATIVE PROGRAMS WITH UNITED STATES GEOLOGICAL SURVEY

Topographic Division:
Water Resources Division:

Daniel Kennedy, Regional Engineer
Anthony Homyk, District Chief

*Certified Professional Geologist by the American Institute of Professional Geologists

CONTENTS

	Page
Abstract	9
Introduction	10
Purpose and scope	10
Cooperation and acknowledgments	10
Description of storms,	12
Meteorological conditions, by U. S. Weather Bureau	12
Rainfall intensity and distribution, by U. S. Weather Bureau	14
Probable recurrence interval of rainfall,	17
Description of floods,	17
Rock Creek basin,	17
Tarkio River basin,	18
Nodaway River basin	18
Platte River basin,	18
Line Creek basin,	29
Fishing River basin	29
Crooked River basin	29
Wakenda Creek basin	35
Lamine River basin,	35
Other basins,	35
Missouri River main stem,	35
Summary of flood damages	35
Flood stages and discharges,	39
Measurement of flood discharges	39
Summary of flood stages and discharges,	39
Magnitude and frequency of floods	51
Comparison with previous floods	56
Station data	57
References	103

ILLUSTRATIONS

	Page
Figure 1. Map of Missouri showing area affected by floods of July 18-23, 1965	11
2. Map of central United States showing meteorological conditions in the lower atmosphere at four selected times during the period July 18-20, 1965	13
3. Isohyetal map of northwestern Missouri showing total precipitation for storm of July 17-20, 1965	15
4. Representative mass rainfall curves for storm of July 17-20, 1965, from U. S. Weather Bureau	16
5. Aerial view of Smithville business district 4 feet below crest of flood . .	24
6. Flood damage to building on Highway 169 in Smithville	25
7. Flood damage on Grove Creek at south edge of Edgerton	26
8. Aerial view of Agency near crest of flood	30
9. Aerial view of Tracy, Highway 92, and Interstate 29, several feet below crest of flood.	31
10. Floodwaters in Mosby several feet below the crest	32
11. Map of northwestern Missouri showing location of flood-measurement sites for floods of July 18-23, 1965.	40
12. Flood hydrographs at gaging stations for floods of July 18-23, 1965 . .	48,49,50
13. Relation of unit discharge to drainage area for Missouri floods	52
14. Relation of peak discharge to drainage area for stations in Rock Creek, Tarkio River, Little Tarkio Creek, Mill Creek, Nodaway River, and Platte River basins for floods of July 18-23, 1965. Frequency curves shown for 10-, 25-, and 50-year floods	53
15. Relation of peak discharge to drainage area for stations in Grand, Fishing, Crooked, Wakenda, and Osage River basins, for floods of July 18-23, 1965. Frequency curves shown for 10-, 25-, and 50-year floods . . .	54
16. Relation of peak discharge to drainage area for stations in Blue, Little Blue, and Blackwater River basins, for floods of July 18-23, 1965. Frequency curves shown for 10-, 25-, and 50-year floods	55

COVER

Highway 92 bridge, west of Platte City, near crest of flood of July 20, 21, 1965. Photograph by Corp of Engineers.

PLATES

	Page
Plate 1. Flood profile of Rock Creek for flood of July 1965.	19
2. Flood profiles of One Hundred and Two and Little Platte Rivers for floods of June 1947 and July 1965	21
3. Flood profile of Platte River for floods of June 1947 and July 1965	27
4. Flood profiles of Fishing River and East Fork Fishing River for flood of July 1965.	33

TABLES

	Page
Table 1. Urban property units flooded, July 1965 flood	36
2. Urban damages, July 1965 flood	37
3. Rural damages, July 1965 flood	38
4. Summary of peak stages and discharges for floods of July 18-23, 1965 and comparison with maximum floods previously known	41

FLOODS OF JULY 18-23, 1965 IN
NORTHWESTERN MISSOURI

by

James E. Bowie
and
E. Eugene Gann

ABSTRACT

The disastrous floods of July 18-23, 1965 in northwestern Missouri were of a frequency greatly in excess of the defined 50-year flood. Recurrence intervals of both rainfall and runoff were extremely high.

Rainfall totaled more than 20 inches in the towns of Rockport and Edgerton during the period July 17-20. Rainfall recorded at Edgerton, in a 24-hour period, was 2.5 times the 100-year point rainfall for northwestern Missouri. The average rainfall that occurred over a 400 square mile area, in 24 hours, was almost double the amount expected for the 100-year rainfall.

Peak discharges at 23 flood measuring sites exceeded the 50-year flood discharge. At 10 of these sites the peak discharge was from 2 to 6 times as large as the discharge for the 50-year flood. The highest known unit rate of runoff ever recorded in Missouri, 6,690 cubic feet per second per square mile, was experienced at Boney Branch at Rockport. The record flood of June 1947 was exceeded in the downstream portions of the One Hundred and Two, Platte, Little Platte, and Fishing River basins. The frequency of the flood in the Fishing River basin increased with increasing size of drainage area.

Four lives were lost during the flood, 729 residences were damaged or destroyed, and 433,700 acres of agricultural lands were flooded. The total flood damage amounted to \$24,292,900.

INTRODUCTION

Outstanding floods occurred July 18-23, 1965 on Missouri River tributaries in an area east of the Missouri River extending from the Iowa-Missouri State line on the north to the Blackwater River basin on the south and east into the Grand River basin (fig. 1). Floodwaters from these tributaries produced extensive flooding on the Missouri River from St. Joseph to its mouth near St. Louis.

The floods were due to torrential rainfalls during July 17-20 following a 4-month period of near normal precipitation. Storm totals amounting to more than 20 inches were reported at Rockport and Edgerton. The Little Platte River at Smithville crested 7.4 feet higher than any previously known flood. The crest on the Platte River, $3\frac{1}{2}$ miles northeast of Agency, where a streamgaging station has been in operation since May 1924, was 4.6 feet higher than any previously recorded stage. Four lives were lost, 15 communities suffered damages and thousands of acres of croplands were flooded.

Purpose and Scope

The purpose of this report is to document these outstanding floods for future hydrologic planning within the State. Data related to unusual floods are essential to wise development, within any basin, where the threat of potential flooding endangers public interests and public safety. This report presents storm and flood descriptions, damage estimates, peak stages and discharges, flood profiles, station data, and discharge hydrographs for the floods of July 18-23, 1965 and indicates the unusually high recurrence interval of both rainfall and runoff associated with this storm.

Cooperation and Acknowledgments

Rainfall data in this report were collected by the Weather Bureau precipitation gaging network and several precipitation gages operated by the U. S. Geological Survey in connection with streamflow network operation. The Weather Bureau and Corps of Engineers collected additional rainfall information by contacting local residents in areas of intense rainfall. These data were used by the Weather Bureau in preparing an isohyetal map and representative mass rainfall curves for the storm. The data are published in the July 1965 issues of Monthly Climatological Data and Hourly Precipitation Data for Iowa, Nebraska and Missouri. Hourly precipitation data collected by the U. S. Geological Survey at Blairstown, Osborn, and Arrow Rock, Missouri were not published but are available from the District office in Rolla, Missouri. The sections on meteorological conditions and on rainfall intensity and distribution were prepared by the Environmental Science Services Administration, Weather Bureau, Kansas City, Missouri. Flood damage



FIG. 1. Map of Missouri showing area affected by floods of July 18-23, 1965.

estimates and flood photographs were furnished by the Corps of Engineers. Flood profiles were prepared jointly by the Corps of Engineers and U. S. Geological Survey. Streamflow data collection was done by the U. S. Geological Survey with the financial cooperation of the Missouri Geological Survey and Water Resources, the Corps of Engineers, and the Missouri State Highway Commission.

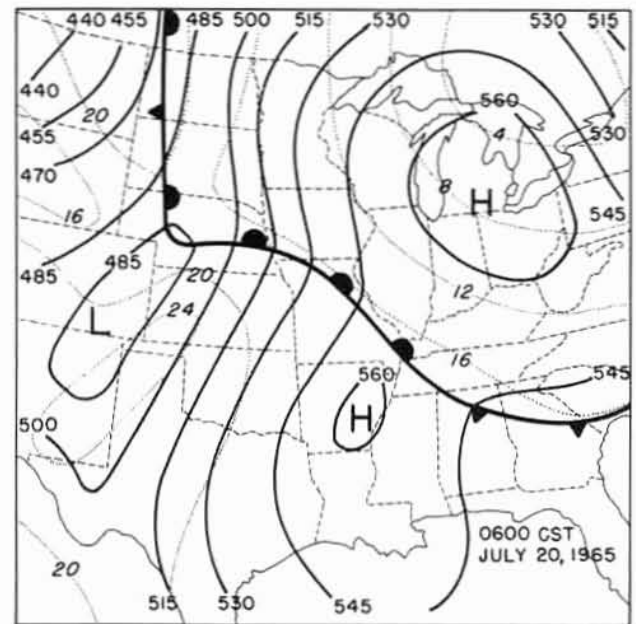
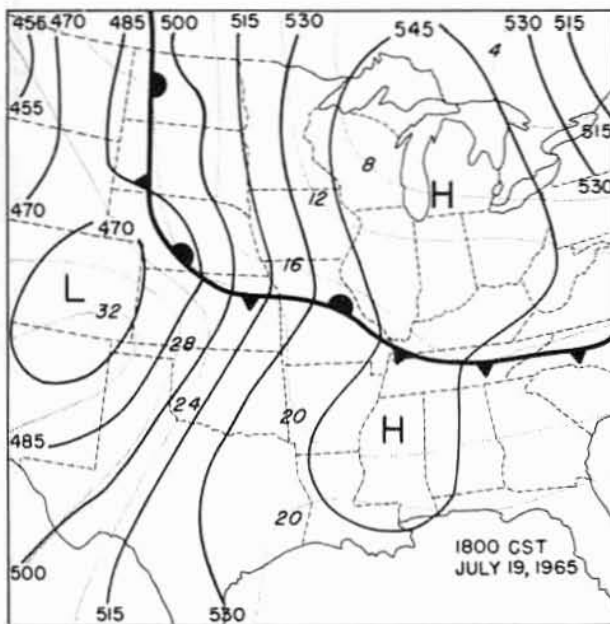
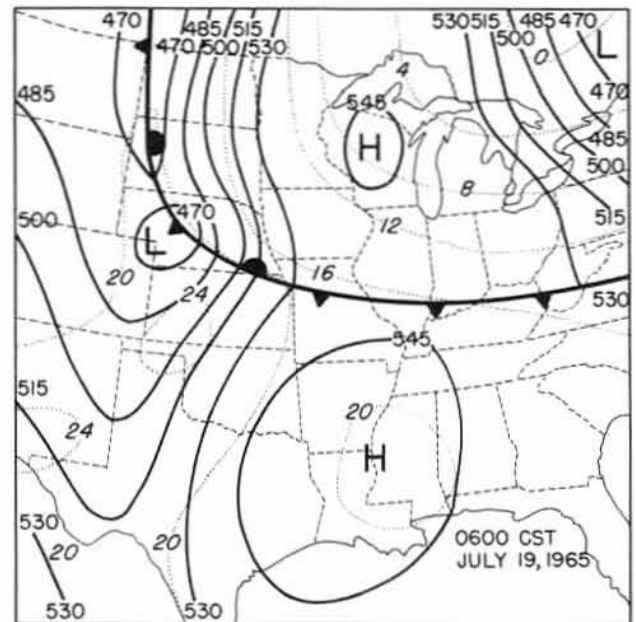
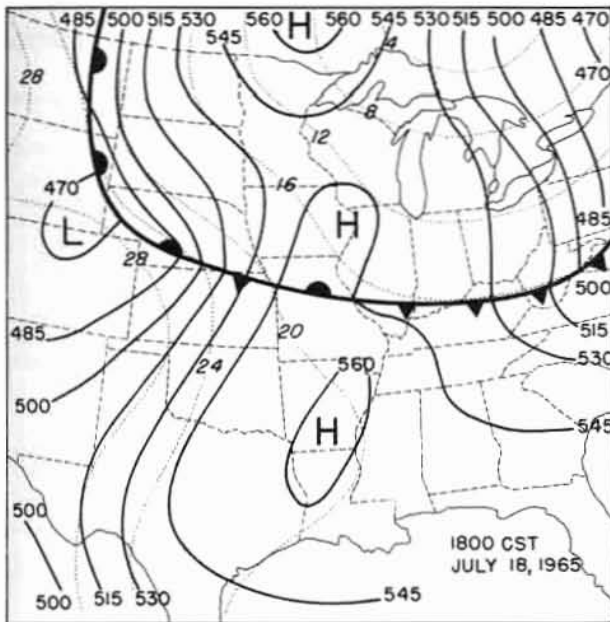
DESCRIPTION OF STORMS

Meteorological Conditions by U. S. Weather Bureau

The meteorological conditions prevailing in the lower atmosphere during the flood period are shown by the charts in figure 2, which depict conditions on the 850 millibar (mb) surface. This level is about 4,000 feet above ground in northwestern Missouri. It will be seen that a quasi-stationary low center was located in the vicinity of Colorado and a quasi-stationary high was over or near Arkansas. A cold migratory high center moved down from Canada and across Lake Michigan. To the south of the front a strong south-southwesterly low-level flow prevailed across Kansas and Oklahoma which provided an abundant moisture supply from the Gulf of Mexico, a necessary condition for heavy rain in the central United States. The front served as a "trigger" mechanism to induce a convergence of the low-level water vapor transport in the rain area.

The surface temperature contrast across the front was quite marked. Mid-afternoon temperatures on July 18 and 19 were in the upper 90's and lower 100's in south-central and southeastern Kansas. Afternoon temperatures to the north of the front were in the upper 70's and lower 80's on July 18 and even cooler July 19 when they were in the lower 70's in northern Missouri and in Iowa. The 850 mb isotherms (dotted lines) in figure 2 also indicate a strong temperature gradient. Cloudiness and cooling by evaporation of falling raindrops to the north of the surface position of the front helped to maintain this temperature contrast. The rain area may be considered to have had a tendency toward self-perpetuation, in the sense that rain and clouds helped to maintain a temperature gradient favorable for further rain.

Slowly-changing weather situations such as this one are more likely to be flood-producing for the reason that the rainfall is concentrated in a small area, rather than being spread over a larger area, as it would be in a more rapidly-moving situation. Steering-level winds (10,000 ft and up) were light west-northwesterly and radar data show that precipitation echoes in the rain area moved generally in an east-southeasterly direction at 15-25 knots (1 knot = 1.15 miles per hour). There was a persistent regeneration of echoes upstream in the steering-level



EXPLANATION

— 500 —

Contours of the 850 millibar surface (about 4,000 feet above ground in northwest Missouri). Heights in meters. Add 1,000 to all contour values.

----- 20 -----

Isotherms in degrees Celsius (Centigrade) of the 850 millibar surface.

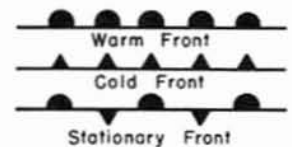


FIG. 2. Map of central United States showing meteorological conditions in the lower atmosphere at four selected times during the period July 18-20, 1965.

flow. The fact that the upper winds steered the thunderstorm cells along paths which were more or less parallel to the front allowed the cells to remain in a region where the low-level convergence and water-vapor supply conditions were favorable for an extended period of time.

An interesting aspect of this situation is the fairly pronounced diurnal variation in rainfall intensity which was apparent. Practically all of the very heavy rainfall occurred in the late afternoon or night. None of the recording gages caught as much as one inch in either of the periods 1200-1500 CST or 1500-1800 CST on July 19, and only one had one inch of rainfall between 0900 CST and 1200 CST on that day. Heavy rain fell before and after these time periods.

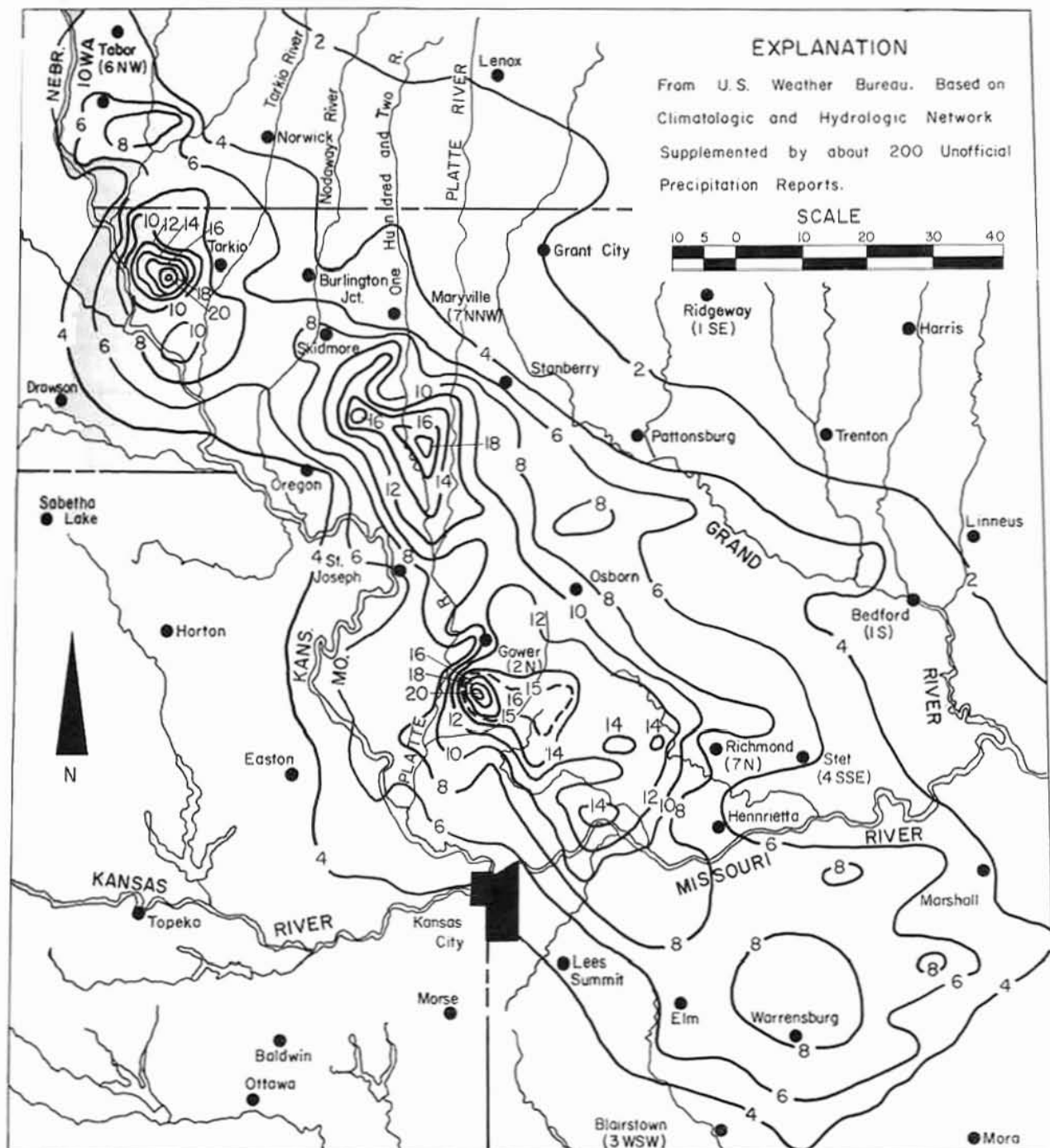
An examination of the southerly low-level winds in the warm air shows a marked diurnal variation in wind speeds. At Wichita, Kansas the wind about 2,700 ft above ground increased from 14 knots at noon on July 18 to 47 knots at midnight. By noon of the 19th it had diminished to 23 knots only to pick up again by the next midnight to 41 knots. This wind variation undoubtedly led to a diurnal variation in the low-level convergence in the frontal zone and helps explain the increase in rainfall at night.

Why did this particular area have so much rain? What was unusual about conditions in the northwest Missouri area? The north-south positioning of the heavy rain can be related quite well to the position of the front at 850 mb. The east-west positioning is somewhat to the east of the axis of the low-level jet, as indicated by the gradient of the contours at 850 mb in figure 2. This eastward shift is not too surprising, since individual thunderstorm cells had a general eastward movement and the water vapor content of the lower atmosphere increased substantially from west to east across Kansas and western Missouri.

Rainfall Intensity and Distribution by U. S. Weather Bureau

The total precipitation for the storm of July 17-20 is shown by the isohyetal map of north western Missouri (fig. 3). The lines were smoothed to represent average amounts in areas where numerous supplemental observations were reported. Representative mass rainfall graphs (fig. 4) were plotted from selected recording rain gage charts. These graphs were grouped with respect to area and give a general indication of time and duration. As examples, the group represented by Elm and Lees Summit, southeast of Kansas City, shows heavy precipitation in the afternoon and evening of July 19. Similarly a group represented by Thurman and Tabor, Iowa shows heavy precipitation in southwestern Iowa and extreme northwestern Missouri near midnight of July 18-19. This group supports the supplemental rainfall reports which established the record-breaking precipitation in the Rockport, Missouri area.

Another group represented by St. Joseph and Skidmore, Missouri shows heavy rain during the morning of July 19 with a second outbreak in the early morning hours of July 20. The greatest amounts observed at official stations were in an area immediately north of Kansas City and in



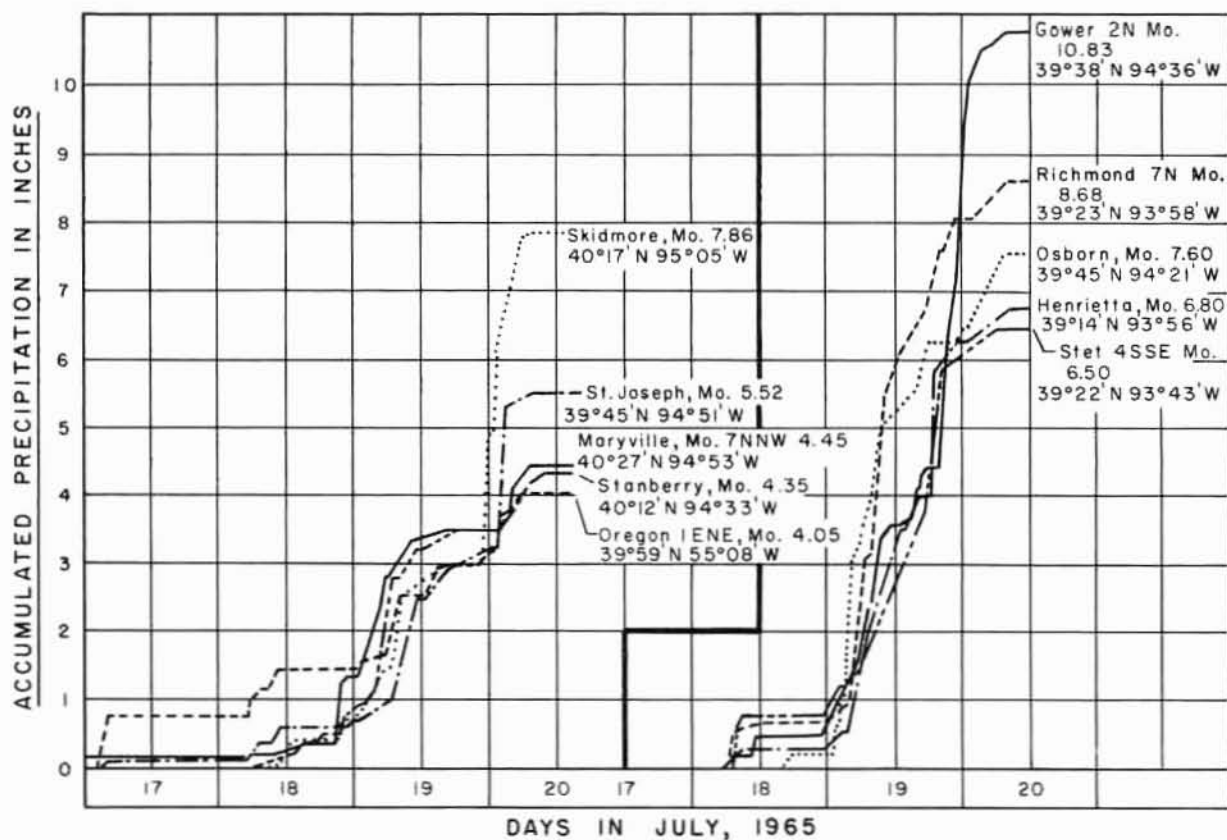
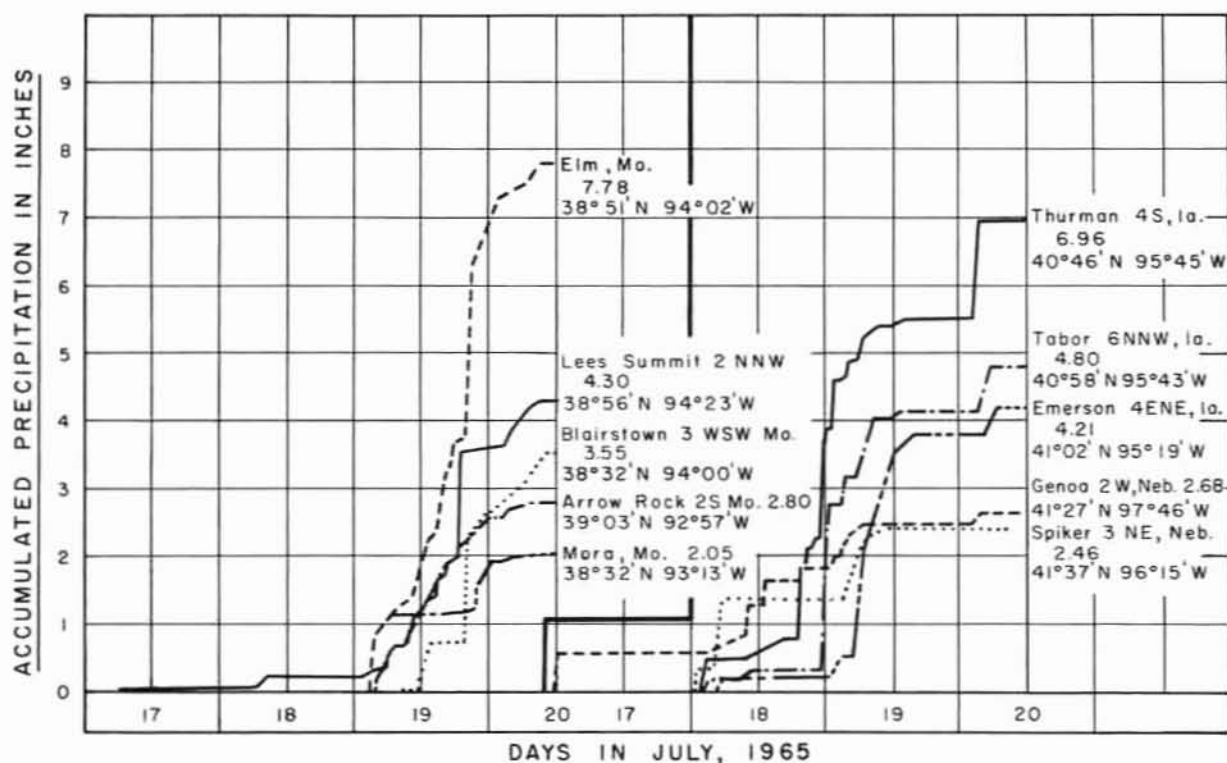


FIG. 4. Representative mass rainfall curves for storm of July 17-20, 1965, from U. S. Weather Bureau.

the lower Platte and Little Platte River basins. Nearly 11 inches of rain, substantially all in the 24-hour period of July 19, were recorded near Gower, Missouri. The official standard 8-inch rain gage station at Edgerton, Missouri reported a storm total of 20.23 inches of which 18.18 inches were reported for the 24-hour period ending the morning of July 20. The total rainfall map and typical mass curves should permit reliable estimates of the time and intensity of the storm for individual areas.

Probable Recurrence Interval of Rainfall

Preliminary rainfall analysis indicates a probable recurrence interval greatly in excess of 100 years. Examination of typical rainfall records near the areas of maximum precipitation indicates that approximately 87 percent of the storm total occurred during a 24-hour period. Depth-area computations, adjusted to a 24-hour period, show that an average of 7.5 inches of rainfall occurred over a 7,000 square mile area. Estimates based on Weather Bureau Technical Paper 40 (Hershfield, 1961, p. 56) indicate that a 24-hour point rainfall of 7.5 inches has a probable recurrence interval of 100 years. The 18.18 inches recorded in 24-hours at Edgerton is about 2.5 times this amount. Figure 15 of Technical Paper 40 shows that, with a recurrence interval of 100 years, approximately 6.9 inches of rainfall may be expected over a 400 square mile area in 24 hours. This storm produced an average of 12.5 inches over 400 square miles in 24 hours or almost double the amount expected for the 100-year rainfall.

Further comparison with Hydrometeorological Report No. 33 (Riedel and others, 1956, p. 20, 21) indicates the 12.5 inches of rainfall experienced over 400 square miles in 24 hours is about half of the probable maximum value of 23 inches, which can be expected for a 400 square mile area in northwest Missouri in a 24-hour period. It should be noted that at no known point within the storm area did point rainfall approach the Weather Bureau's world record figure for 42 minutes of 12.0 inches (Jennings, 1950, p. 4, 5) as recorded on June 22, 1947, in Fishing River basin, at Holt, Missouri.

It is evident from these comparisons that the probable recurrence interval of the July 17-20 precipitation is extremely high.

DESCRIPTION OF FLOODS

The floods are discussed by basins in downstream order. Several basins where relatively minor flooding occurred, are discussed as a group. The descriptive material presented is from Corps of Engineers reports, newspaper accounts, and personal observation of the authors.

Rock Creek basin

Rockport (pop. 1,310) in the lower part of Rock Creek Basin, was the center of the storm

cell which produced the maximum reported rainfall. This rainfall was 21 inches in 36 hours, of which 13 inches was reported by newspapers (The Kansas City Times, July 20, 1965, p. 1, 5) to have fallen in a 3-hour period starting at 6:00 P.M. (1800 hours) on Sunday night, July 18. Rockport was the only town in the basin to suffer extensive flood damage. Water from Boney Branch and Rock Creek inundated about 60 percent of the city, covering the entire business district to a depth of 2 to 3 feet. Damage to crops, roads, and bridges occurred in the vicinity of and downstream from Rockport in the lower part of the basin. Flood profiles for Rock Creek are shown in plate 1.

Tarkio River basin

Flooding on the Tarkio River was not severe, and only minor flooding occurred in various low-lying areas. Two distinct peaks occurred during the storm period of almost the same magnitude, 9,200 and 9,440 cfs, at the streamflow station at Fairfax. These peaks were considerably less than have been recorded on other occasions.

Nodaway River basin

This flood was minor on the Nodaway River except in the lower end of the basin below the streamflow station at Burlington Junction where more than 7,000 acres of croplands were flooded and heavy damage to roads and bridges resulted.

Platte River basin

The One Hundred and Two River basin, a major tributary to the Platte River from the west, received heavy rains below Maryville, as indicated by figure 3. At the streamgaging station on One Hundred and Two River near Maryville, where the maximum flood in 33 years of record occurred on June 14, 1947, the July 19, 1965 flood peak was 10 feet below that of the 1947 flood. The flood profile (pl. 2) shows that from Bolckow, 24 miles downstream from Maryville, to the mouth of the One Hundred and Two River, flood crest elevations for the 1965 flood ranged from 2 to 10 feet higher than the 1947 flood elevations. Rosendale (pop. 234), near the center of an area where 18 inches of rain occurred in the 3-day period, was heavily damaged by the flooding of 17 residences, 8 businesses, and 1 public building.

The Little Platte River, in the southeastern part of the Platte River basin, was severely flooded throughout its entire length. Considerable damage was done to crops, roads, and bridges in the rural stretches of the stream. The Little Platte River at Smithville reached a stage of 44.8 feet, 21.5 feet above flood stage. This was 7.4 feet above the previous highest known flood of July 1947. Plate 2 shows the flood profiles of both the 1965 and the 1947 floods. Smithville, a community of 1,254 population, was the major flood damage center of the storm

EXPLANATION

ELEVATIONS, REFERRED TO MEAN SEA LEVEL, ARE BASED
ON THE U.S. COAST AND GEODETIC SURVEY, 1929 GENERAL ADJUSTMENT.

HIGH WATER MARKS

RIGHT BANK ---- □
LEFT BANK ---- △

NOTES

1965 HIGH WATER MARK ELEVATIONS
FURNISHED BY U.S.E.D.
CO BR -- COUNTY BRIDGE
RR ---- RAILROAD
EST ---- ESTIMATED

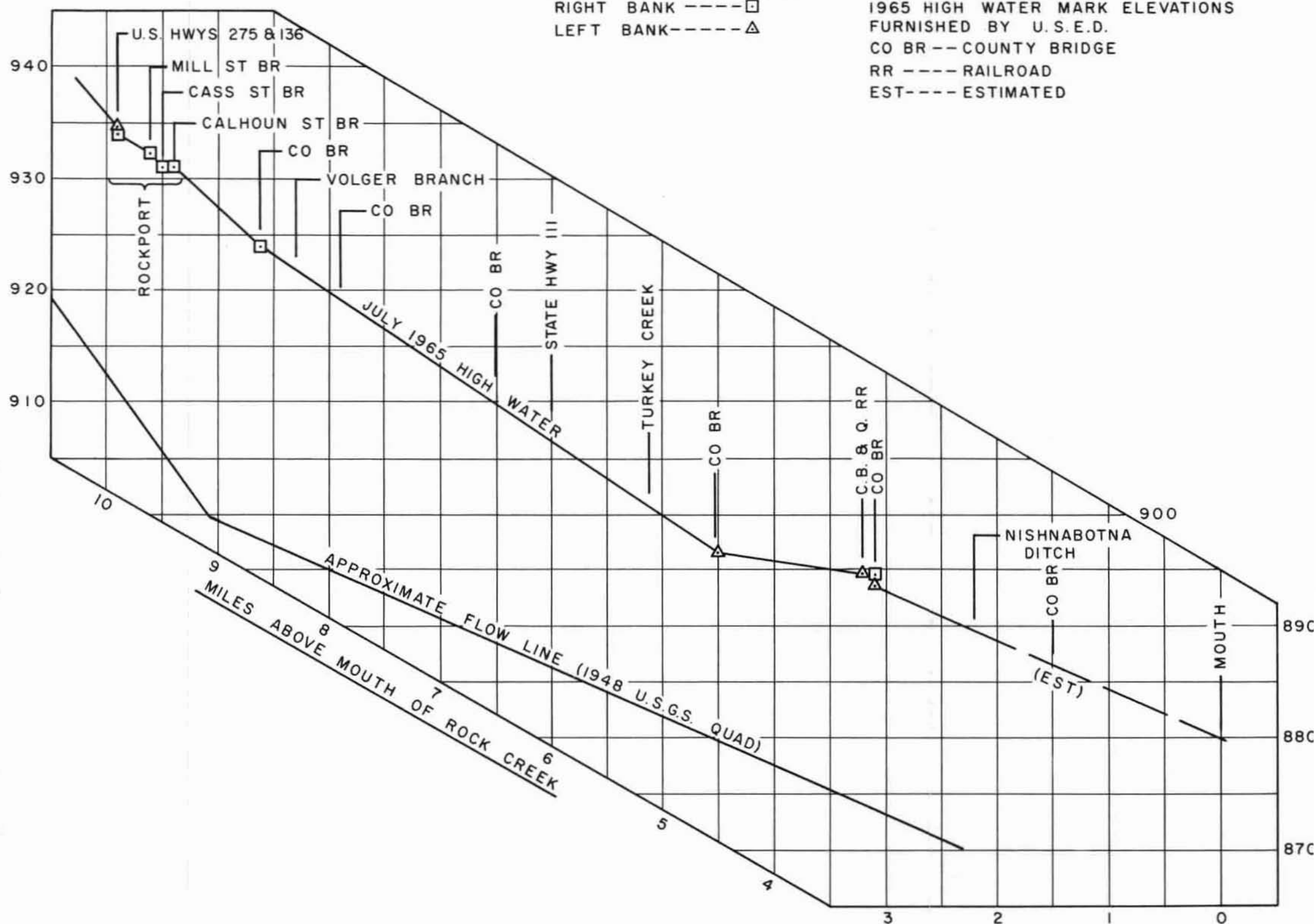


PLATE I--Flood Profile of Rock Creek for Flood of July, 1965.

(figs. 5 and 6). Of the 200 homes flooded by the Little Platte River, 46 were destroyed or so severely damaged that they were condemned or razed. The flood damaged 67 business places, 5 churches and church properties, the high school, the city water supply pumping stations, the sanitary lagoon, and various other municipal properties. The telephone exchange was out of service for 4 days.

Castile Creek, which enters the Platte River from the east between One Hundred and Two and Little Platte Rivers, also experienced flooding. Rainfall for the period July 17-20 ranged from 8 to 14 inches over the basin. Jenkins Branch, a tributary to Castile Creek, experienced a stage 2.5 feet higher than the previous highest stage in 15 years of record at the stream-gaging station at Gower.

Grove Creek, a tributary to the Platte River below Castile Creek, flooded the town of Edgerton (pop. 449) on the night of July 19, causing extensive damage (fig. 7). The area drained by Grove Creek was in the center of one of the storm cells where over 20 inches of rainfall was reported. The flood profile of Platte River (pl. 3) indicates that tributaries in the vicinity of Edgerton contributed large amounts of floodwater to the Platte River. Twelve homes, about 25 automobiles, and 3 bridges were destroyed in Edgerton.

On the main stem of the Platte River disastrous flooding occurred from Rochester to the river's mouth. At various points downstream from Edgerton the flood crest reached elevations 9 feet higher than the previous highest known flood of June 1947 (pl. 3). The towns of Agency, Tracy, and Farley were inundated as the river rose to a record crest of 35.05 feet at the stream-gaging station near Agency. The crest was 4.6 feet above the previous record stage of 30.46 feet recorded in June 1947. Records at this station have been collected since May 1924. Approximately 85 percent of the town of Agency (pop. 240) was inundated (fig. 8). Thirty-three residences and one mobile home were flooded, and 13 of the residences have been abandoned since the flood. Two churches and the Post Office were severely damaged. The business district of Agency, which has been subjected to many floods, suffered only moderate losses.

Farther downstream, Interstate Highway 29 was overtopped and traffic stopped near Platte City. At Tracy (pop. 208), about one mile downstream from Interstate Highway 29 on Highway 92, about one-third of the residential area was flooded by the Platte River (fig. 9). Water depths reached about 15 feet in the lower sections of the town inundating 24 dwellings, 6 mobile homes, 2 churches, 6 business places, and the Platte County Fairgrounds. About 90 persons were forced to leave their homes and many of them were unable to remove their furniture and personal belongings. Highway 92, west of the community, was closed for about 4 days.



FIG. 5. Aerial view of Smithville business district 4 feet below crest of flood. Photograph by Corps of Engineers.



FIG. 6. Flood damage to building on Highway 169 in Smithville. Photograph by Corps of Engineers.



FIG. 7. Flood damage on Grove Creek at south edge of Edgerton. Photograph by Corps of Engineers.

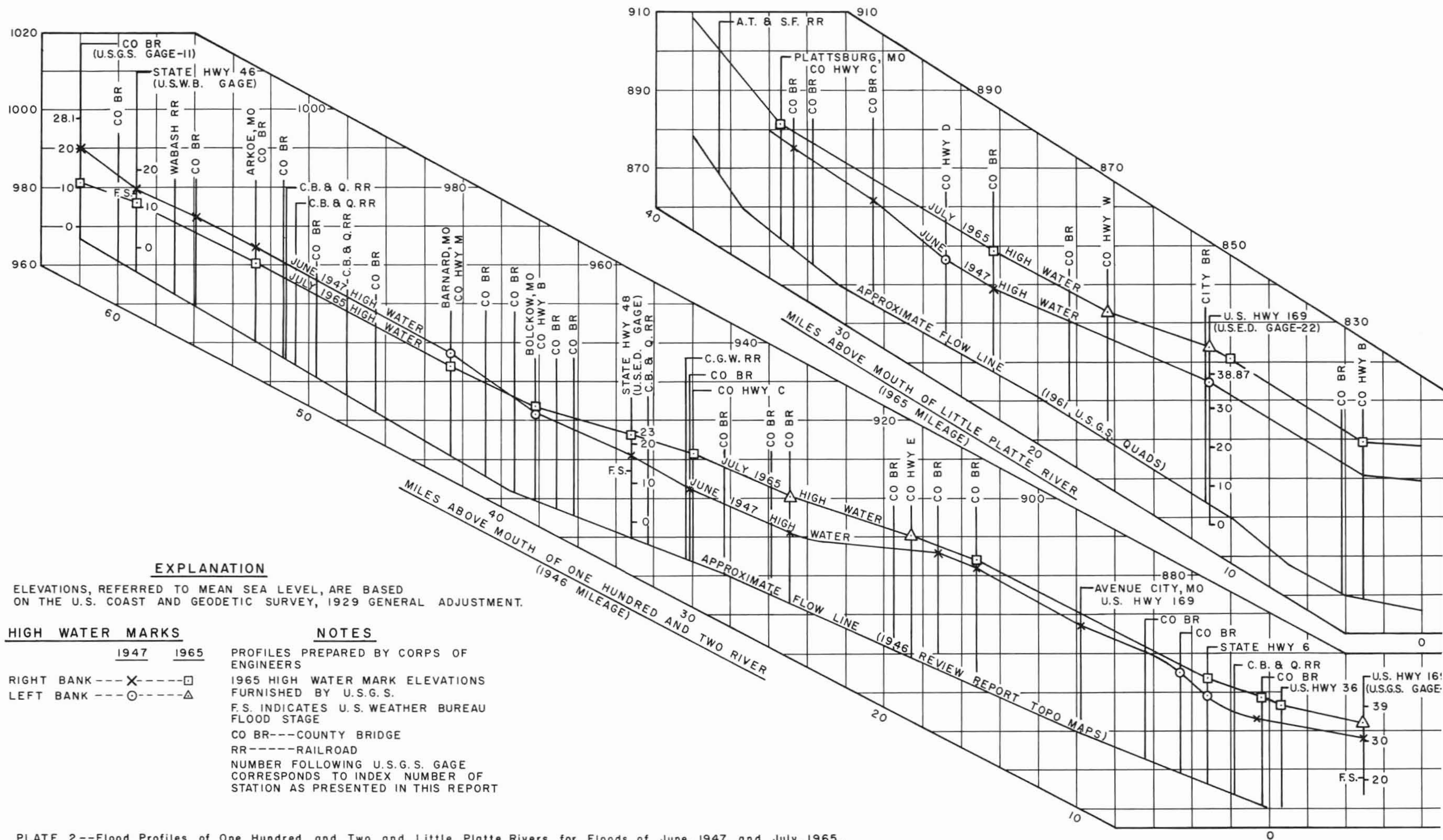


PLATE 2--Flood Profiles of One Hundred and Two and Little Platte Rivers for Floods of June, 1947 and July, 1965.

ELEVATIONS, REFERRED TO MEAN SEA LEVEL, ARE BASED ON THE U.S. COAST AND GEODETIC SURVEY, 1929 GENERAL ADJUSTMENT.

NOTES

PROFILES PREPARED BY CORPS OF
ENGINEERS

1965 HIGH WATER MARK ELEVATIONS
FURNISHED BY U.S.G.S.
F.S. INDICATES U.S. WEATHER BUREAU
FLOOD STAGE
CO BR---COUNTY BRIDGE
RR-----RAILROAD
NUMBER FOLLOWING U.S.G.S. GAGE
CORRESPONDS TO INDEX NUMBER OF
STATION AS PRESENTED IN THIS REPORT

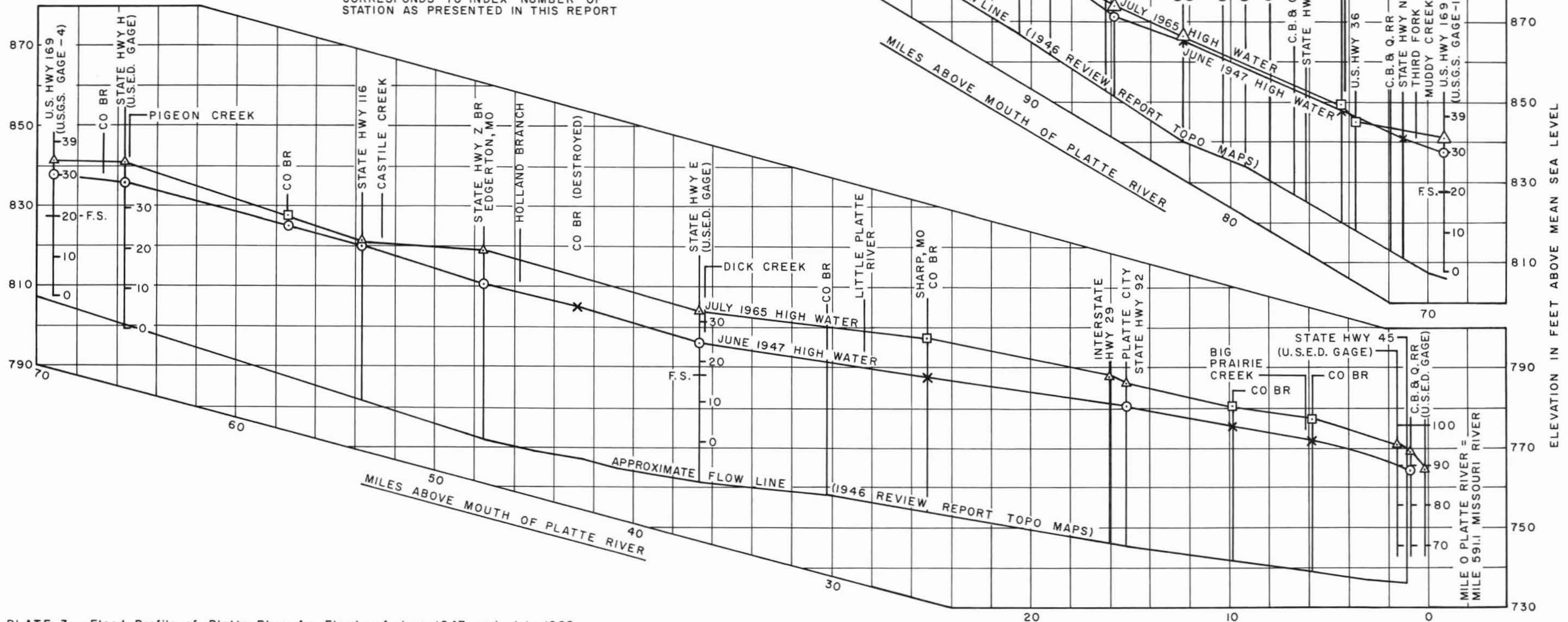


PLATE 3--Flood Profile of Platte River for Floods of June, 1947 and July, 1965.

At Farley (pop. 120), near the mouth of the Platte River, 8 residences, 4 businesses and 1 public building were flooded.

Line Creek basin

Severe damage was reported by the communities of Riverside and Northmoor, in Line Creek basin, north of Kansas City. Damaged or completely destroyed property included 41 trailers, 7 new apartment buildings, a motel, the dam at Drennen Lake, and 16 automobiles, and minor damage occurred in 8 dwellings, a church, and several small businesses.

Fishing River basin

Rainfall and runoff were exceptionally heavy throughout the Fishing River basin. On the night of July 19, Fishing River overflow covered 90 percent of Mosby (pop. 292) to an average depth of 6 feet necessitating the evacuation of the entire area (fig. 10). Flood waters damaged 95 residences, 9 businesses and 4 public buildings. Access to the town was severely hampered because the south lane of Highway 69 was blocked and a county bridge at the south edge of town was destroyed. Crops, roads, and bridges were heavily damaged throughout the basin by the raging flood waters.

Recorded stages at the streamgaging station on East Fork Fishing River at Golf Hill Drive bridge in Excelsior Springs, where continuous record has been collected since Oct. 1950, indicate that the 1965 flood was 0.7 foot higher than the previous maximum of record occurring in 1951. However, at Isley Boulevard (Highway 10), about one-fourth mile downstream from the streamgaging station, high-water marks indicate that the June 1947 flood exceeded the 1965 flood by 1.5 feet. In Excelsior Springs (pop. 6,473) the most severe damage occurred in the residential areas along Dry Fork and East Fork. A private levee protected many business places on East Fork, while sandbagging and pumping operations lessened the severity of damage to several otherwise unprotected hotels, mineral water resorts, and clinics. About 68 dwellings, 3 hotels, 25 business places, a school, a church, and the Hall of Waters were in the flooded area. The city's waterworks, sewerage disposal plant, and streets sustained severe damage, and part of the city was without water for about $1\frac{1}{2}$ days. Flood profiles for Fishing River and East Fork Fishing River are shown in plate 4.

Crooked River basin

At the streamgaging station 4 miles north of Richmond, Crooked River reached a stage nearly 2 feet higher than any stage recorded since record collection began in March 1948. At the town of Hardin (pop. 727), downstream from Richmond, 77 residences, 4 business places, and 1 public building were flooded. The principal monetary damage in this basin resulted from 17,700



FIG. 8. Aerial view of Agency near crest of flood. Photograph by Corp of Engineers.



FIG. 9. Aerial view of Tracy, Highway 92, and Interstate 29, several feet below crest of flood. Photograph by Corps of Engineers.



FIG. 10. Floodwaters in Mosby several feet below the crest. Photograph by Corp of Engineers.

EXPLANATION

ELEVATIONS, REFERRED TO MEAN SEA LEVEL, ARE BASED ON THE U.S. COAST AND GEODETIC SURVEY, 1929 GENERAL ADJUSTMENT.

HIGH WATER MARKS

RIGHT BANK ---- □
LEFT BANK ---- △

NOTES

PROFILES PREPARED BY CORPS OF ENGINEERS
1965 HIGH WATER MARK ELEVATIONS FURNISHED BY U.S.G.S.
F.S. INDICATES U.S. WEATHER BUREAU FLOOD STAGE
CO BR---COUNTY BRIDGE
RR-----RAILROAD
NUMBER FOLLOWING U.S.G.S. GAGE CORRESPONDS TO INDEX NUMBER OF STATION AS PRESENTED IN THIS REPORT

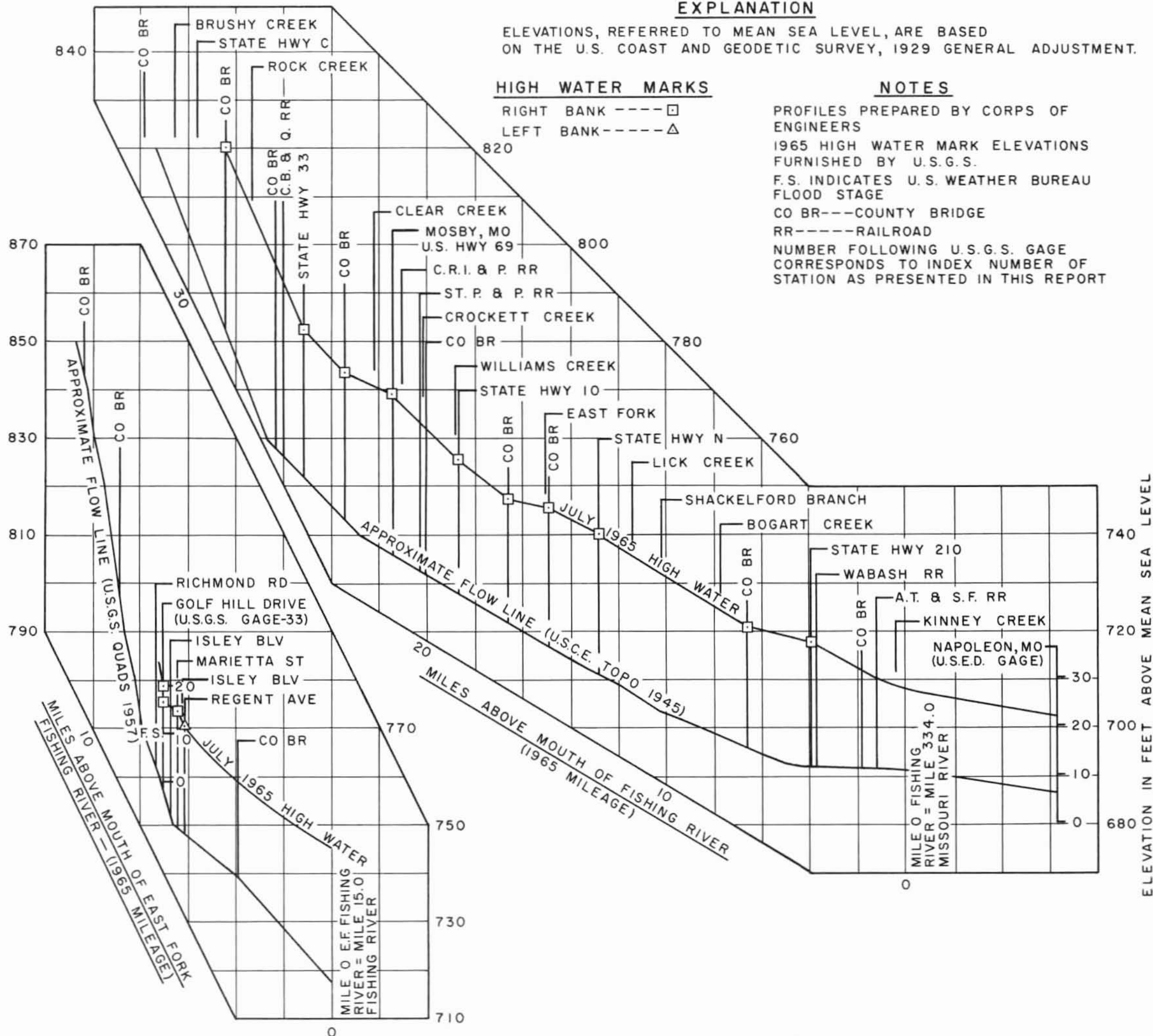


PLATE 4--Flood Profiles of Fishing River and East Fork Fishing River for Flood of July, 1965.

acres of flooded crop lands.

Wakenda Creek basin

Wakenda Creek reached the third highest stage since record collection began in March 1948 at the Carrollton streamgaging station. Flood stage was exceeded by 7.9 feet. This stage caused considerable damage to rural areas, but no municipal damages were reported.

Lamine River basin

The Blackwater River, lying south of the Missouri River and draining the northwestern part of the Lamine River basin, was the southern boundary of the flood area. The river exceeded flood stage by 11.4 feet at the Valley City streamgaging station and 12.5 feet at the Blue Lick station. The flood crest elevation at the Valley City station was within 0.3 feet of the maximum stage of the September 1961 flood. Considerable damage occurred in rural areas to agricultural crops and lands.

Other basins

Several other Missouri River tributaries within the flood area also experienced various degrees of flooding. Included among these are the Little Tarkio, Squaw, Mill, and Dillon Creeks and the Blue, Little Blue, and minor parts of the Grand and Osage Rivers. Of these, Dillon Creek which flooded 8 residences and 5 businesses in the town of Amazonia (pop. 326) caused the most urban damage. Little Tarkio Creek, Squaw Creek, and Little Blue River caused considerable damage to agricultural crops and products.

Missouri River main stem

The Missouri River main stem exceeded flood stage at the St. Joseph streamgaging station and at all other downstream stations to its mouth. At Waverly, where records have been collected since 1929, the peak stage for this flood was within 1.4 feet of the maximum stage of record, which occurred in July 1951. Although the peak stage at all Missouri River stations was well below the maximum stage of record, more than half of the total estimated rural damage resulting from these floods occurred in the low-lying areas along this river. More than 280,000 acres of land were flooded and about 200,000 acres of crops were damaged or destroyed. Crop losses were especially severe because flooding occurred at the height of the growing season leaving behind thousands of acres of worthless, waterlogged plants.

SUMMARY OF FLOOD DAMAGES

Estimated flood damages, furnished by the Corps of Engineers, for the floods of July 18-23, 1965 are summarized in tables 1-3, which list respectively, urban property units flooded, urban

Table 1 -- Urban property units flooded, July 1965 flood

<u>Basin and community</u>	<u>Population (1960 census)</u>	<u>Residences</u>	<u>Businesses</u>	<u>Public and Quasi-public</u>
<u>Rock Creek</u>				
Rockport	1,310	100	40	Not available
<u>Dillon Creek</u>				
Amazonia	326	8	5	-
<u>Line Creek</u>				
Riverside and Northmoor	2,011	49	12	1
<u>Platte River</u>				
Rosendale	234	17	8	1
Agency	240	34	5	4
Edgerton	449	35	6	-
Smithville	1,254	200	67	8
Tracy	208	30	6	3
Farley	120	8	4	1
Easton	198	3	-	-
<u>Fishing River</u>				
Excelsior Springs	6,473	68	28	4
Mosby	293	95	9	4
<u>Crooked River</u>				
Hardin	727	77	4	1
Henrietta	497	4	-	-
<u>Blackwater River</u>				
Sweet Springs	1,452	1	-	-
		<u>729</u>	<u>194</u>	<u>27</u>

Table 2 -- Urban damages, July 1965 flood

<u>Basin and community</u>	<u>Residential</u>	<u>Business</u>	<u>Municipal and quasi-public</u>	<u>Other *</u>	<u>Total</u>
<u>Rock Creek</u>					
Rockport	\$140,000	\$160,000	\$300,000	\$5,000	\$605,000
<u>Dillon Creek</u>					
Amazonia	24,400	5,200	9,200	100	38,900
<u>Line Creek</u>					
Riverside & Northmoor	105,400	66,700	800	1,600	174,500
<u>Platte River</u>					
Rosendale	31,800	14,600	3,000	100	49,500
Agency	83,200	8,800	12,400	1,100	105,500
Edgerton	109,700	10,100	25,200	2,400	147,400
Tracy	79,600	50,000	10,300	2,900	142,800
Smithville	1,079,900	1,295,600	250,100	171,600	2,797,200
Farley	11,000	11,200	1,200	200	23,600
Maryville	-	-	3,000	-	3,000
Gower	-	-	1,800	-	1,800
Easton	6,300	-	2,000	-	8,300
Total Platte River	1,401,500	1,390,300	309,000	178,300	3,279,100
<u>Fishing River</u>					
Excelsior Springs	82,500	119,700	162,000	9,700	373,900
Mosby	298,200	101,200	31,300	23,300	454,000
Total Fishing River	380,700	220,900	193,300	33,000	827,900
<u>Crooked River</u>					
Hardin	54,100	5,000	5,500	1,400	66,000
Henrietta	1,600	-	400	-	2,000
Total Crooked River	55,700	5,000	5,900	1,400	68,000
<u>Blackwater River</u>					
Sweet Springs	2,300	-	10,600	100	13,000
Total urban damages	2,110,000	1,848,100	828,800	219,500	5,006,400

*Other includes utility damage, costs of temporary shelter, and minor items not included elsewhere.

Table 3 -- Rural damages, July 1965 flood

<u>Stream</u>	<u>Acres flooded</u>		<u>Estimate of damages</u>		
	<u>Total</u>	<u>Crop</u>	<u>Agricultural</u>	<u>Transportation & Utilities</u>	<u>Total</u>
Rock Creek	Not available		\$ 149,000	\$320,000	\$ 469,000
Missouri River					
Main stem	281,700	199,600	10,400,000	500,000	10,900,000
Little Tarkio Creek	8,800	8,500	466,500	2,400	468,900
Squaw Creek	12,700	5,100	364,400	1,300	365,700
Nodaway River	7,900	7,600	792,100	21,300	813,400
Platte River and minor tributaries	35,100	34,100	2,383,800	16,600	2,400,400
One Hundred and Two River	18,100	17,800	677,500	24,900	702,400
Little Platte River	9,200	9,000	354,900	12,500	367,400
Little Blue River	3,000	2,400	111,800	0	111,800
Fishing River	10,000	9,000	588,700	165,000	753,700
Crooked River	19,900	17,700	855,300	22,000	877,300
Wakenda Creek	3,300	2,900	182,700	2,000	184,700
Blackwater River	<u>24,000</u>	<u>22,600</u>	<u>868,800</u>	<u>3,000</u>	<u>871,800</u>
Total	433,700	336,300	18,195,500	1,091,000	19,286,500

damages, and rural damages.

The total estimated monetary damage amounted to \$24,292,900, of which about \$5,006,400 was concentrated in urban communities within the storm area and \$19,286,500 occurred in rural areas. More than 729 residences, 194 businesses, and 27 public or quasi-public buildings were damaged or destroyed in 15 flooded communities. An estimated 433,700 acres of agricultural lands were flooded, including 281,700 acres along the Missouri River from above St. Joseph to the mouth and 152,000 acres along tributaries in the storm area. These figures do not include acreage in Rock Creek basin which was not available.

The monetary damages assessed to the flood waters cannot evaluate human suffering, misery and inconvenience. Four deaths were attributed to the flood by the Corps of Engineers, and 9 deaths were reported by the American Red Cross. The Corps, Red Cross, nearby communities, and many individuals assisted in evacuation of people and property and helped maintain temporary shelters to provide the necessities of life following the flood period.

FLOOD STAGES AND DISCHARGES

Measurement of Flood Discharges

Flood discharges at the 22 regular streamgaging stations presented in this report (table 4 and fig. 11) were determined by current meter measurements or by stage-discharge relation. Indirect measurements of flow were made at the stations on Little Platte River at Smithville and East Fork Fishing River at Excelsior Springs. Indirect measurements were also required at 1 of the 7 crest-stage gages and at all 17 of the miscellaneous sites presented. Methods used in both the current meter and indirect measurements were according to standard U.S. Geological Survey procedures.

Summary of Flood Stages and Discharges

Peak stage and discharge at all continuous-recording stations and crest-stage gages and at several miscellaneous sites within the flood area are summarized in table 4. Peak discharges are shown on a per square mile basis and as a ratio to the 50-year flood discharge. Index numbers in the table apply to the location map (fig. 11). The list is in downstream order and gives the Geological Survey station number, station name, drainage area, period of record, and maximum flood previously known. More than one flood is shown in the maximum flood previously known column for those stations where the maximum previously known gage height and discharge occurred during different floods or where a known flood outside the period of record is greater than the maximum flood within the period of record.

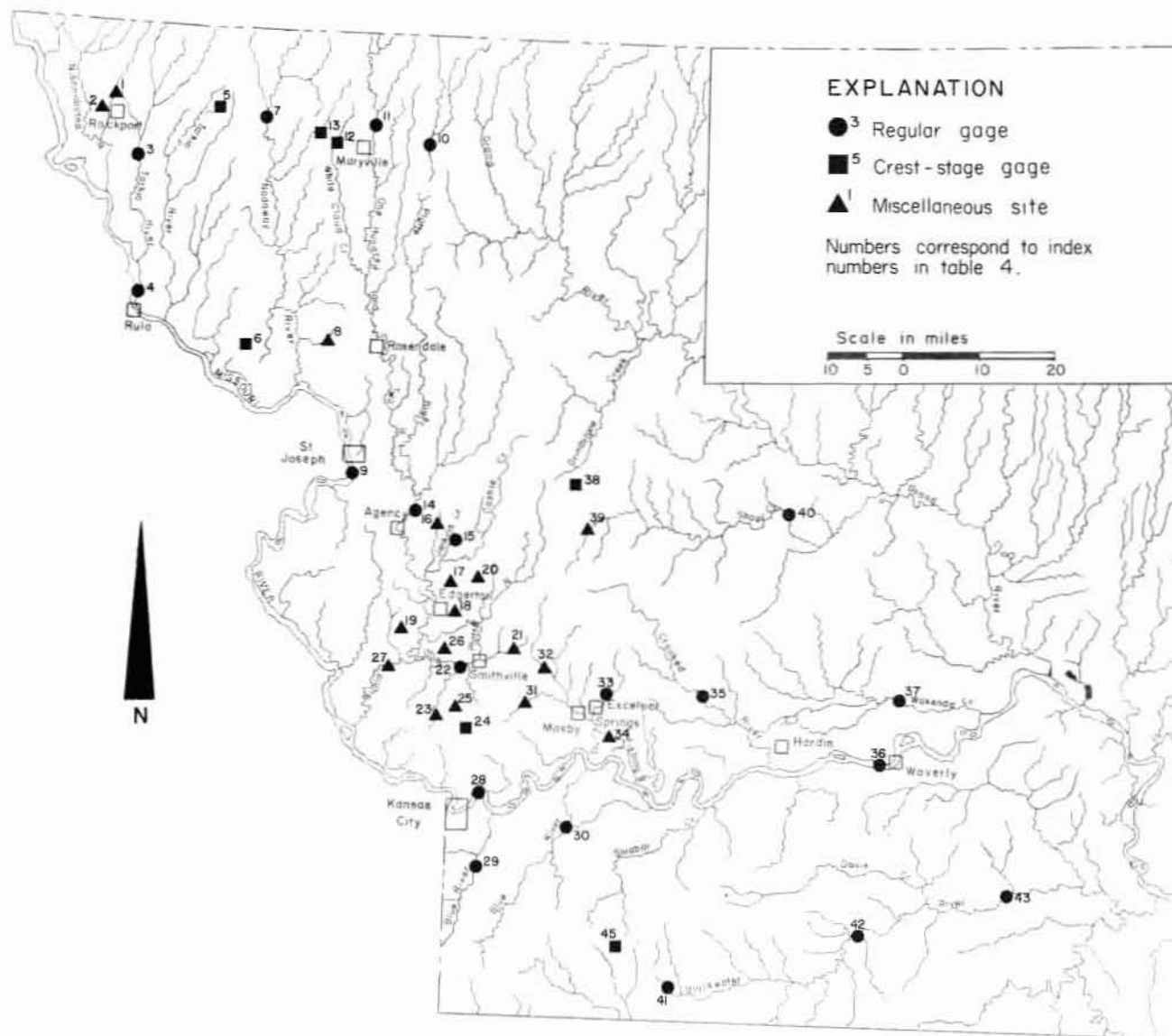


FIG. 11. Map of northwestern Missouri showing location of flood-measurement sites for floods of July 18-23, 1965.

TABLE 4

SUMMARY OF PEAK STAGES AND DISCHARGES FOR FLOODS OF JULY 18-23, 1965 AND COMPARISON
WITH MAXIMUM FLOODS PREVIOUSLY KNOWN

definition of symbols on page 47

Index number	Station number	Station name	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum flood July 18-23, 1965				
					date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge		
										Cfs	Cfs per sq mi	Ratio* to Q ₅₀
		ROCK CREEK BASIN										
1	Misc.	Rock Creek at Rockport	40.1	--	-----	--	-----	July 18	-	8,260	206	1.1
2	Misc.	Boney Branch at Rockport	.76	--	-----	--	-----	July 18	-	5,080	6,690	6.0
		TARKIO RIVER BASIN										
3	6-8130	Tarkio River at Fairfax	508	1922-65	July 7, 1929	22.33	-----	July 20	19.63	9,440	18.6	0.3
					June 20, 1942	--	16,300	--	-	-----	--	--
		MISSOURI RIVER MAIN STEM										
4	6-8135	Missouri River at Rulo, Nebr.	418,905	1949-65	Apr. 22, 1952	25.60	358,000	July 20	16.12	85,000	--	--
		LITTLE TARKIO CREEK BASIN										
5	6-8155.5	Staples Branch near Burlington Junction	.49	1959-65	June 21, 1964	15.72	430	July 19	10.94	50	102	0.1
		MILL CREEK BASIN										
6	6-8160	Mill Creek at Oregon	4.90	1951-65	Sept. 3, 1961	7.10	2,730	July 19	3.65	359	73.3	0.2

TABLE 4 -- continued

SUMMARY OF PEAK STAGES AND DISCHARGES FOR FLOODS OF JULY 18-23, 1965 AND COMPARISON
WITH MAXIMUM FLOODS PREVIOUSLY KNOWN

definition of symbols on page 47

Index number	Station number	Station name	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum flood July 18-23, 1965				
					Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge		Ratio* to Q ₅₀
										Cfs	Cfs per sq mi	
NODAWAY RIVER BASIN												
7	6-8175	Nodaway River near Burlington Junction	1,240	1922-65	June 14, 1947 Mar. 5, 1949	-- a 19.69	32,000 -----	July 19	8.4	7,120	5.74	0.2
8	Misc.	Lincoln Creek near Fillmore	20.7	----	-----	--	-----	July 19	-	6,170	298	1.2
MISSOURI RIVER MAIN STEM												
9	6-8180	Missouri River at St. Joseph	424,300	1881 1928-65	Apr. 29, 1881 Apr. 22, 23, 1952	27.2 26.82	b 370,000 397,000	July 20 --	18.22 -	119,000 ----	- -	- -
PLATTE RIVER BASIN												
10	6-8189	Platte River at Ravenwood	486	1958-65	Mar. 29, 1960	c 18.40	11,000	July 19	4.21	680	1.40	0.02
11	6-8195	One Hundred and Two River near Maryville	500	1932-65	June 14, 1947	d 21.20	14,200	July 19	11.20	2,520	5.04	0.1
12	6-8200	White Cloud Creek near Maryville	6.06	1949-65	June 1, 1949	13.41	4,100	July 19	10.63	1,030	170	0.4
13	6-8203	Big Slough near Wilcox	1.30	1950-65	June 15, 1964	6.43	1,040	July 19	3.33	320	246	0.3
14	6-8205	Platte River near Agency	1,760	1924-30 1932-65	June 23, 1947	30.46	50,000	July 20	35.05	53,000	30.1	1.0

TABLE 4 -- continued

SUMMARY OF PEAK STAGES AND DISCHARGES FOR FLOODS OF JULY 18-23, 1965 AND COMPARISON
WITH MAXIMUM FLOODS PREVIOUSLY KNOWN

definition of symbols on page 47

Index number	Station number	Station name	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum flood July 18-23, 1965				
					Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge		
										Cfs	Cfs per sq mi	Ratio* to Q ₅₀
15	6-8210	Jenkins Branch at Gower	2.72	1950-65	June 21, 1964	10.77	2,420	July 20	13.27	3,460	1,270	2.0
16	Misc.	Malden Creek near Gower	9.24	----	-----	--	-----	July 20	-	12,100	1,310	3.7
17	Misc.	Mitchell Branch near Edgerton	1.56	----	-----	--	-----	July 19	-	3,490	2,240	2.8
18	Misc.	Grove Creek tributary near Edgerton	1.03	----	-----	--	-----	July 19	-	2,770	2,690	2.8
19	Misc.	Alger Creek at Camden Point	2.36	----	-----	--	-----	July 19	-	3,000	1,270	1.9
20	Misc.	Linn Branch tributary at Grayson	.79	----	-----	--	-----	July 19	-	2,410	3,050	2.8
21	Misc.	Camp Branch at Arley	9.78	----	-----	--	-----	July 19	-	5,430	555	1.6
22	6-8211.5	Little Platte River at Smithville	243	1947 1964-65	June 22, 1947 June 22, 1964	37.4 36.4	26,000 20,000	July 20 --	44.8 -	76,600 ----	315 -	4.0 -
23	Misc.	Second Creek at Linkville	9.99	----	-----	--	-----	July 19	-	10,000	1,000	2.9
24	6-8211.3	First Creek near Nashua	.55	1959-65	May 7, 1961	13.25	310	July 19	18.40	831	1,510	1.2
25	Misc.	First Creek near Linkville	5.23	----	-----	--	-----	July 19	-	4,430	847	1.8
26	Misc.	Little Platte River trib- utary near Smithville	.44	----	-----	--	-----	July 19	-	1,270	2,890	2.0

TABLE 4 -- continued

SUMMARY OF PEAK STAGES AND DISCHARGES FOR FLOODS OF JULY 18-23, 1965 AND COMPARISON
WITH MAXIMUM FLOODS PREVIOUSLY KNOWN

definition of symbols on page 47

Index number	Station number	Station name	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum flood July 18-23, 1965				
					Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge		
										Cfs	Cfs per sq mi	Ratio* to Q ₅₀
27	Misc.	Platte River at Platte City	2,400	--	-----	--	-----	July 20	-	114,000	47.5	1.8
		MISSOURI RIVER MAIN STEM										
28	6-8930	Missouri River at Kansas City	489,200	1844	June 16, 1844	38.0	^b 625,000	July 21	22.80	225,000	-	-
				1897-1965	July 14, 1951	36.2	573,000	--	--	----	-	-
		BLUE RIVER BASIN										
29	6-8935	Blue River near Kansas City	188	1939-65	Sept. 13, 1961	44.46	41,000	July 20	18.95	3,970	21.1	0.2
		LITTLE BLUE RIVER BASIN										
30	6-8940	Little Blue River near Lake City	184	1948-65	Sept. 14, 1961	27.94	9,460	July 20	25.03	5,200	28.3	0.2
		FISHING RIVER BASIN										
31	Misc.	Fishing River near Roosterville	24.7	--	-----	--	-----	July 19	-	13,500	547	1.6
32	Misc.	Clear Creek near Kearney	29.4	--	-----	--	-----	July 19	-	17,900	609	1.9
33	6-8945	East Fork Fishing River at Excelsior Springs	20.0	1947	June 22, 1947	^e 23.7	(f)	July 19	16.05	10,500	525	1.4
				1951-65	July 6, 1951	15.3	12,000	--	-	----	-	-
34	Misc.	Fishing River at Miltondale	238	1947	June 22, 1947	--	^b 32,000	July 20	-	80,200	337	2.7

TABLE 4 -- Continued

SUMMARY OF PEAK STAGES AND DISCHARGES FOR FLOODS OF JULY 18-23, 1965 AND COMPARISON
WITH MAXIMUM FLOODS PREVIOUSLY KNOWN

definition of symbols on page 47

Index number	Station number	Station name	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum flood July 18-23, 1965				
					Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge		
										Cfs	Cfs per sq mi	Ratio* to Q ₅₀
		CROOKED RIVER BASIN										
35	6-8950	Crooked River near Richmond	159	1948-65	July 6, 1951	28.8	27,000	July 20	30.70	29,000	182	1.2
		MISSOURI RIVER MAIN STEM										
36	6-8955	Missouri River at Waverly	491,200	1929-65	July 16, 1951 ^g	28.20	549,000	July 22	26.80	276,000	-	-
		WAKENDA CREEK BASIN										
37	6-8960	Wakenda Creek at Carrollton	248	1948-65	Mar. 20, 1948	--	7,000	July 21	22.90	5,500	22.2	0.2
					July 17, 1951 ^h	23.4	-----	--	-----	----	-	-
					July 2, 1960	--	7,000	--	-----	----	-	-
		SELECTED STATIONS IN GRAND RIVER BASIN										
38	6-8967	O'Neill Branch at Osborn	.80	1955-65	July 30, 1958	24.20	1,320	July 19	18.28	510	638	0.4
39	Misc.	Shoal Creek near Turney	23.3	--	-----	--	-----	July 19	-----	9,640	414	1.2
40	6-8997	Shoal Creek near Braymer	391	1957-65	June 22, 1964	29.05 ⁱ	26,000	July 22	26.00	8,600	22.0	0.2
		SELECTED STATIONS IN LAMINE RIVER BASIN										
41	6-9075	South Fork Blackwater River near Elm	16.4	1951	July 1951	14.8	(f)	July 19	11.12	4,610	281	0.8
				1954-65	Apr. 15, 1960	12.0	5,600	--	-----	-----	-	-

TABLE 4 -- continued

SUMMARY OF PEAK STAGES AND DISCHARGES FOR FLOODS OF JULY 18-23, 1965 AND COMPARISON
WITH MAXIMUM FLOODS PREVIOUSLY KNOWN

definition of symbols on page 47

Index number	Station number	Station name	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum flood July 18-23, 1965				
					Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge		
										Cfs	Cfs per sq mi	Ratio* to Q ₅₀
42	6-9077	Blackwater River at Valley City	547	1958-65	Apr. 16, 1960	--	66,500	July 20	31.38	57,000	104	1.4
					Sept. 14, 1961	31.75	-----	--	-	-----	-	-
43	6-9080	Blackwater River at Blue Lick	1,120	1922-33 1938-65	Nov. 18, 1928	41.25	54,000	July 23	37.50	26,000	23.2	0.4
44	6-9090	Missouri River at Boonville	505,700	1844 1925-65	June 21, 1844	32.7 ^b	710,000	July 23	26.05	253,000	-	-
					July 17, 1951	32.82	550,000	--	-	-----	-	-
45	6-9217	West Branch Crawford Creek near Lees Summit	.80	1955-65	Apr. 6, 1960	15.57	839	July 19	15.73	900	1,120	0.7
46	6-9345	Missouri River at Hermann	528,200	1844 1897-1965	June 1844	35.5 ^b	892,000	July 24	25.40	256,000	-	-
					June 6, 7, 1903	--	676,000	--	-	-----	-	-
					July 19, 1951	33.33	-----	--	-	-----	-	-

TABLE 4 -- continued

SUMMARY OF PEAK STAGES AND DISCHARGES FOR FLOODS OF JULY 18-23, 1965 AND COMPARISON
WITH MAXIMUM FLOODS PREVIOUSLY KNOWN

- * Ratio of peak discharge to 50-year flood discharge.
- a Affected by backwater from ice.
- b Computed by Corps of Engineers.
- c Outside gage stage of 18.8 ft.
- d Also, stage at unknown date prior to 1932, from floodmarks.
- e Stage at point on right bank, 200 ft upstream from gage. Floods of July 6, 1951 and July 19, 1965.
reached stages of 20.0 and 19.7 ft, respectively, at same point (from floodmarks).
- f Discharge unknown.
- g Occurred two days earlier than peak discharge.
- h Affected by backwater and overflow from Missouri River.
- i Levee break, discharge occurred after crest at stage of 28.0 ft.
- j Occurred 5 hrs earlier than peak stage.

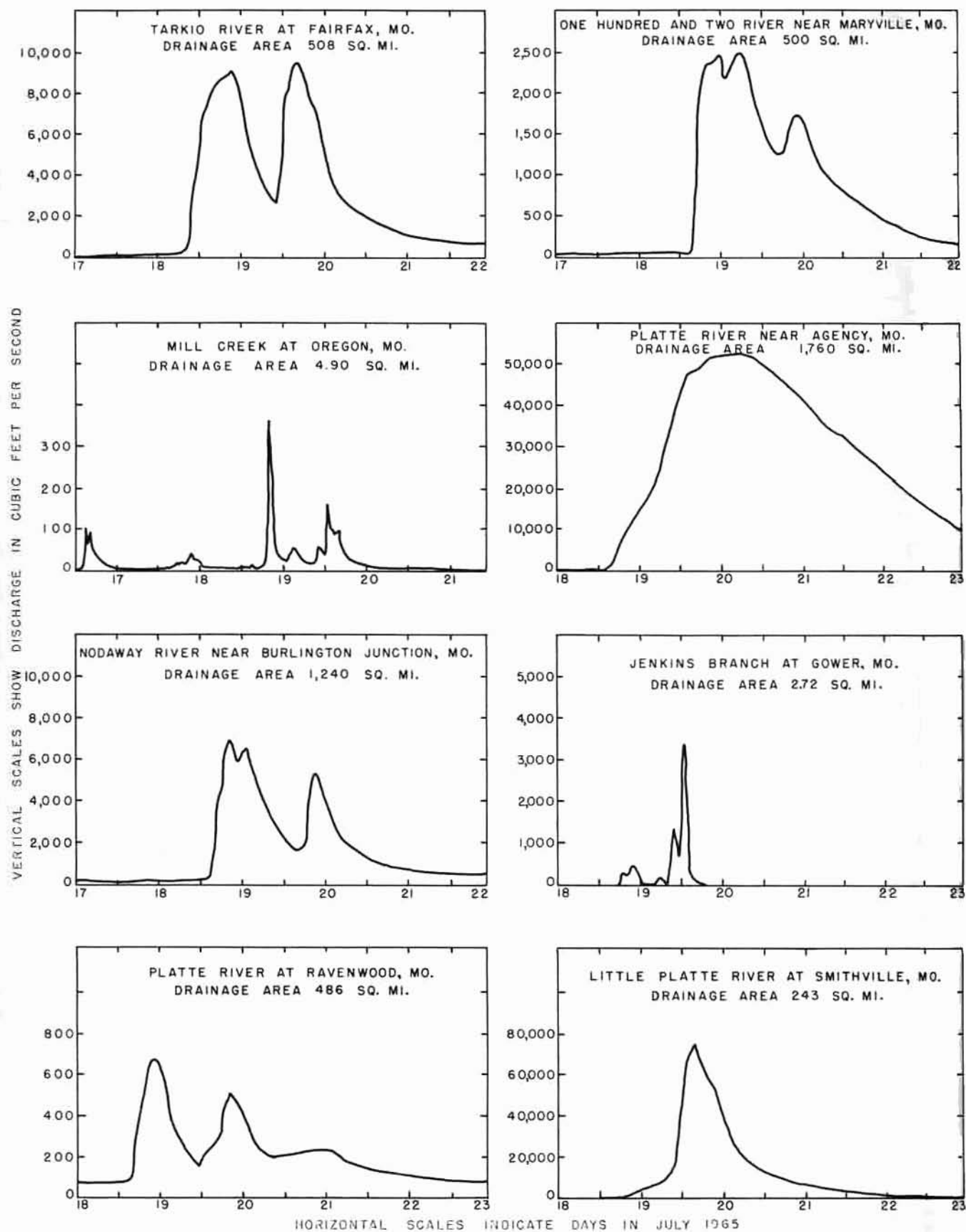


FIG. 12. Flood hydrographs at gaging stations for floods of July 18-23, 1965.

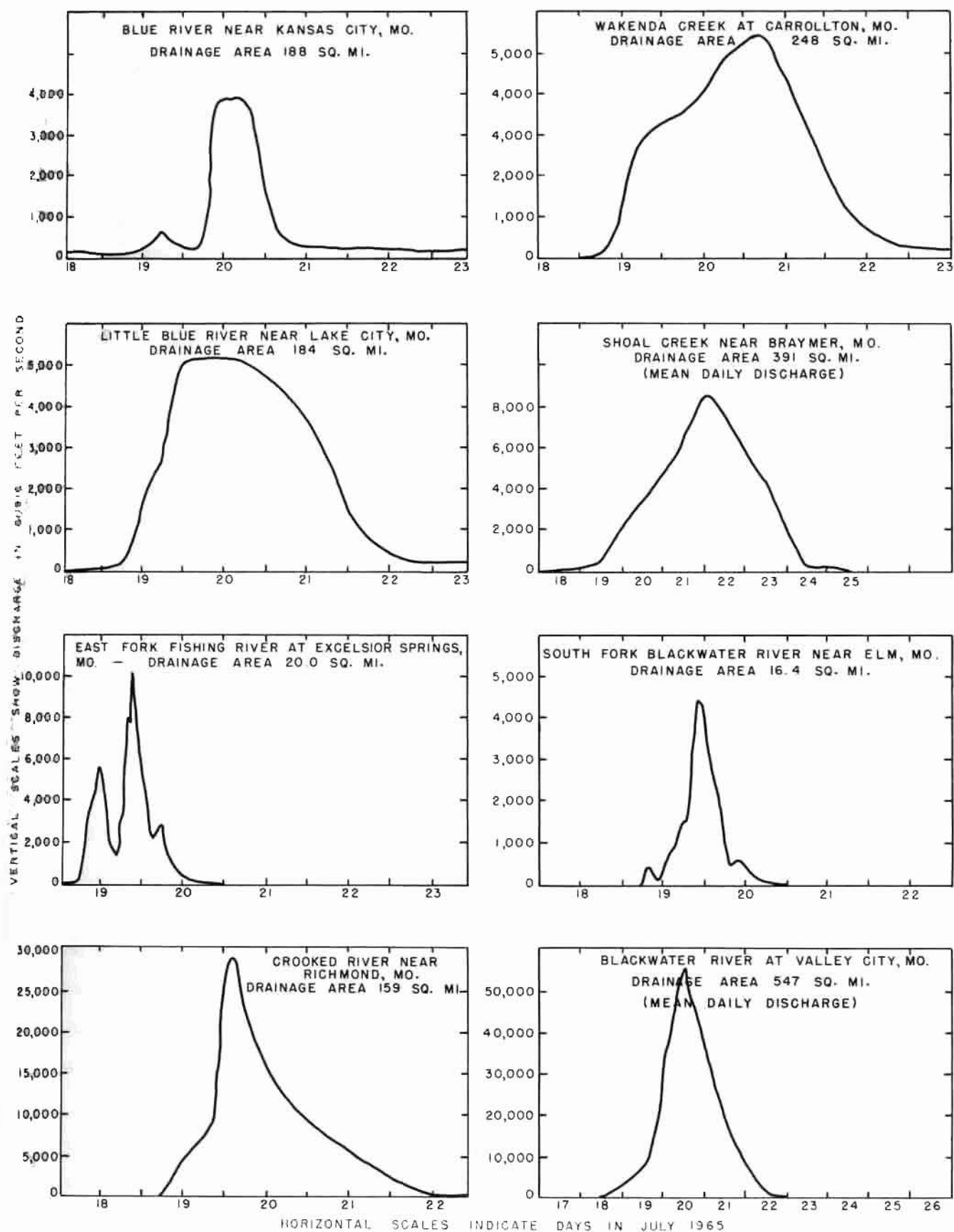


FIG. 12. Continued

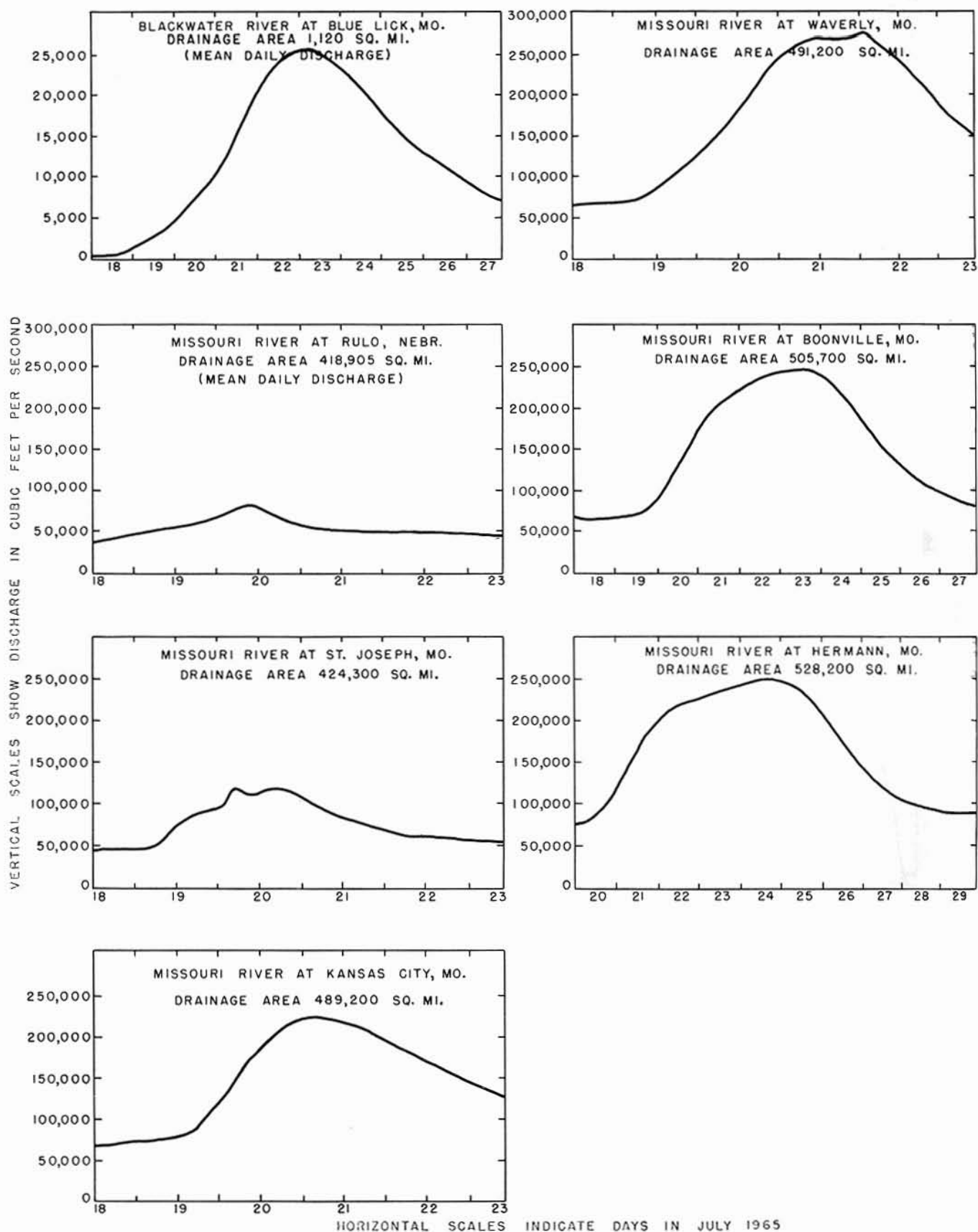


FIG. 12. Continued

Detailed data on stage and discharge at all regular gaging stations in the flooded basins are included in the Station Data section, page 57. These data were used to prepare hydrographs of flow for the flood period (fig. 12). Daily mean gage heights and discharges published in the "1965 Surface Water Records of Missouri" may not exactly agree with corresponding means computed from the detailed data shown because of different selected time increments.

A diagram of the maximum known peak discharges for the July 1965 floods and previous floods throughout the State, having cubic feet per second per square mile plotted against drainage area in square miles, is shown in figure 13. The Myers rating for 60 percent is shown on this plot. Figure 13 indicates that the 6,690 cfs per square mile (cfsm) that occurred on Boney Branch in July 1965 was the highest known unit rate of runoff ever recorded in Missouri. The two highest known unit rates of runoff for Missouri streams draining more than 100 square miles occurred in July 1965 at stations on the Little Platte River at Smithville and Fishing River at Milondale where 315 and 337 cfsm, respectively, were recorded. Only three streams in Missouri have been measured which produced peak discharges with unit rates of runoff greater than the 60 percent Myers curve. These unusually high runoff rates occurred at Isle du Bois Creek near Ste. Genevieve (June 1964), Kinsey Creek at Kinsey (June 1964) and Little Gravois Creek near Bagnell (Aug. 1944).

Magnitude and Frequency of Floods

Diagrams of the peak discharge in cubic feet per second plotted against the drainage area in square miles, with the 10-, 25-, and 50-year flood frequency curves for Part 6B (Matthai, H. F. - written communication) are presented in figures 14-16. Numbers corresponding to those in figure 11 and table 4 identify all known peak discharges during the flood. No estimate of the recurrence interval in excess of 50 years can be made based on the observed data now available. A study of the diagrams indicates that the flood was of an unusually high magnitude. Of the 25 stations shown in figure 14, 16 had peak discharges greater than the 50-year flood. At 9 of these stations the peak discharge was from 2 to 6 times as large as the discharge for the 50-year flood. The 8 stations where the discharge did not approach or exceed the 50-year flood were in areas of light rainfall as shown on the isohyetal map (fig. 3).

Figure 15 indicates that the 50-year flood was exceeded at all measured sites (Nos. 31-35) in the Fishing and Crooked River basins and at one site (No. 39) in the Grand River basin. The frequency of the flood in the Fishing River basin appears to have increased with increasing size of drainage area as shown by the plotting position of Nos. 31-34 in figure 15.

Only one station south of the Missouri River, Blackwater River at Valley City, had a peak

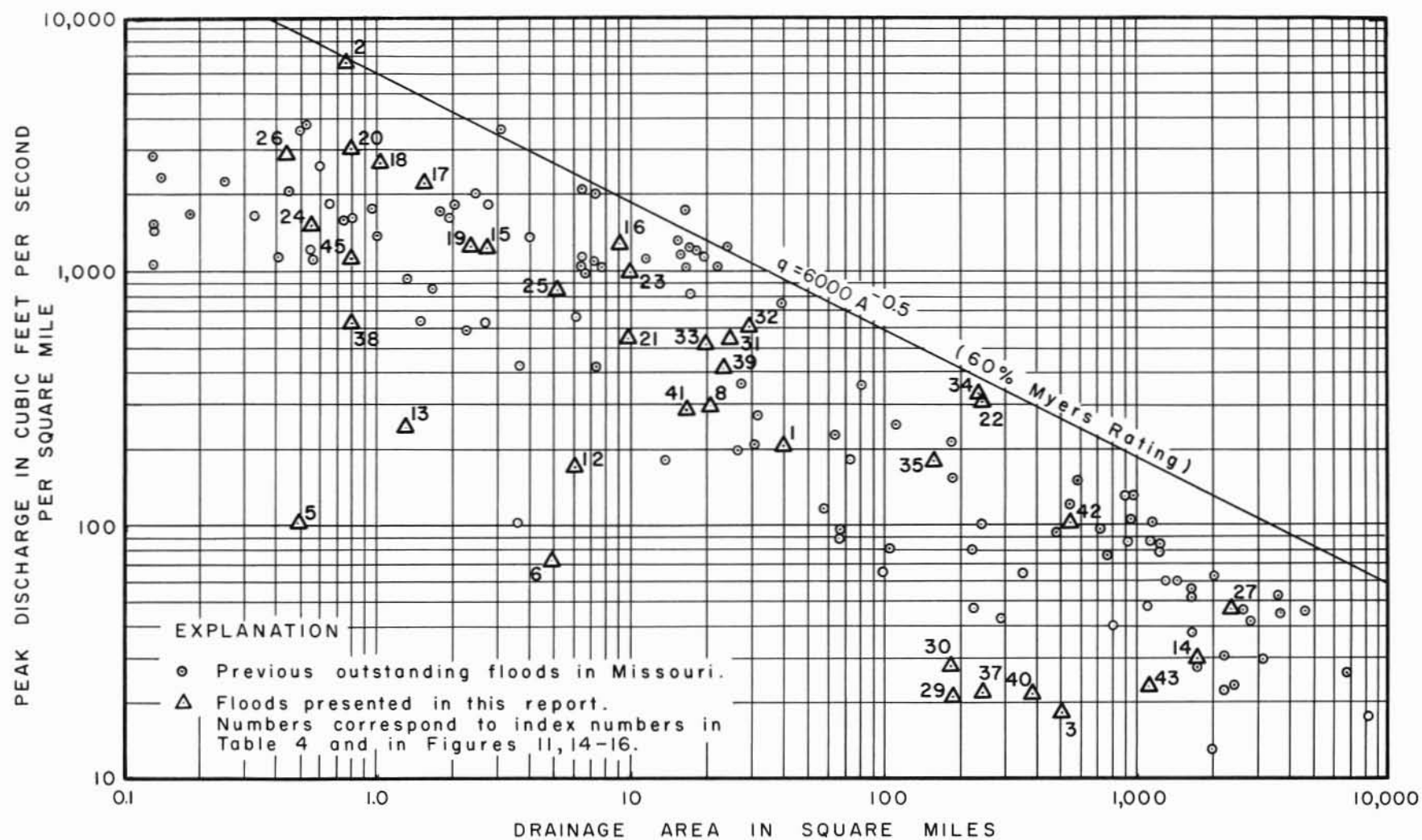


FIG. 13. Relation of unit discharge to drainage area for Missouri floods.

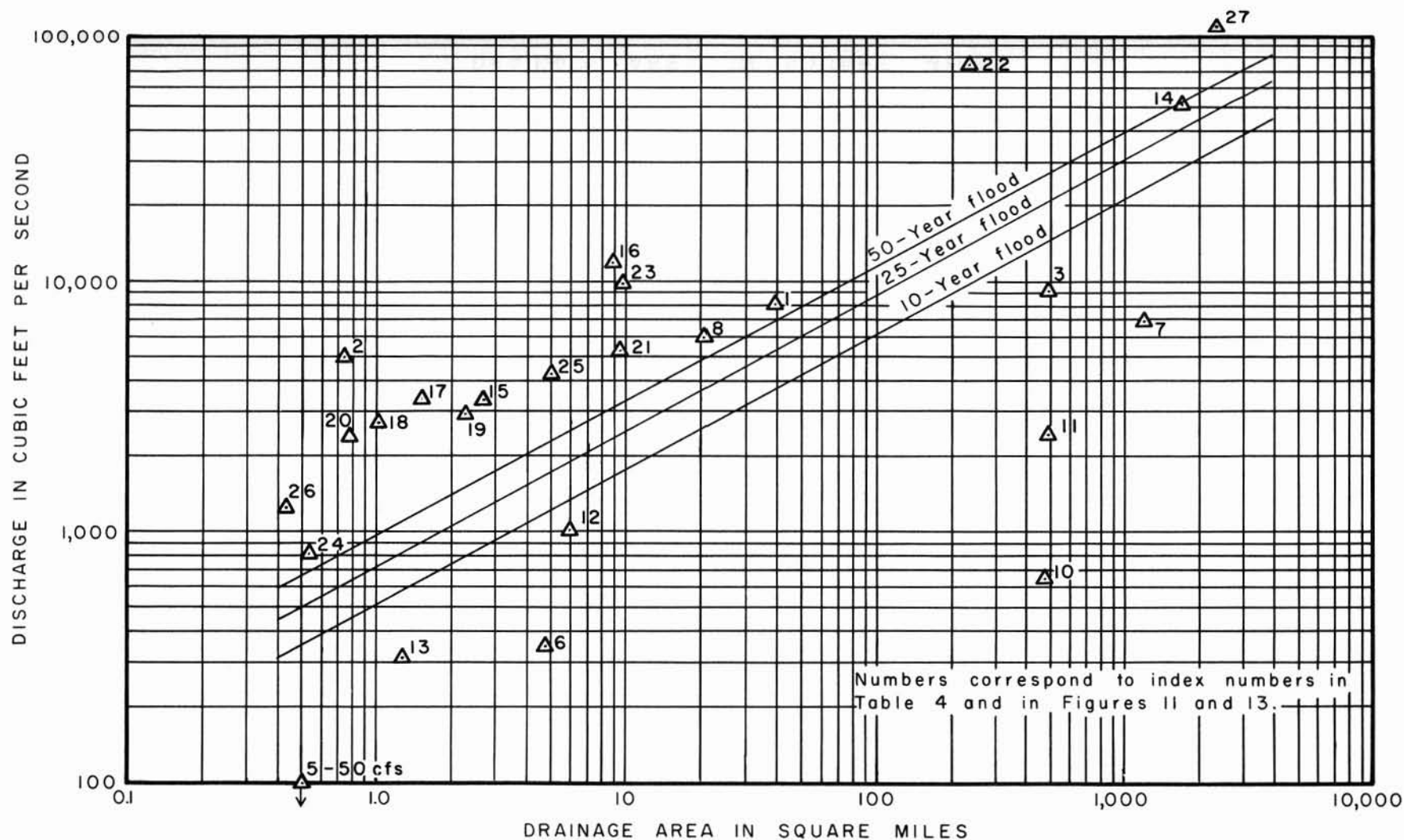


FIG. 14. Relation of peak discharge to drainage area for stations in Rock Creek, Tarkio River, Little Tarkio Creek, Mill Creek, Nodaway River, and Platte River basins for floods of July 18-23, 1965. Frequency curves shown for 10-, 25-, and 50-year floods.

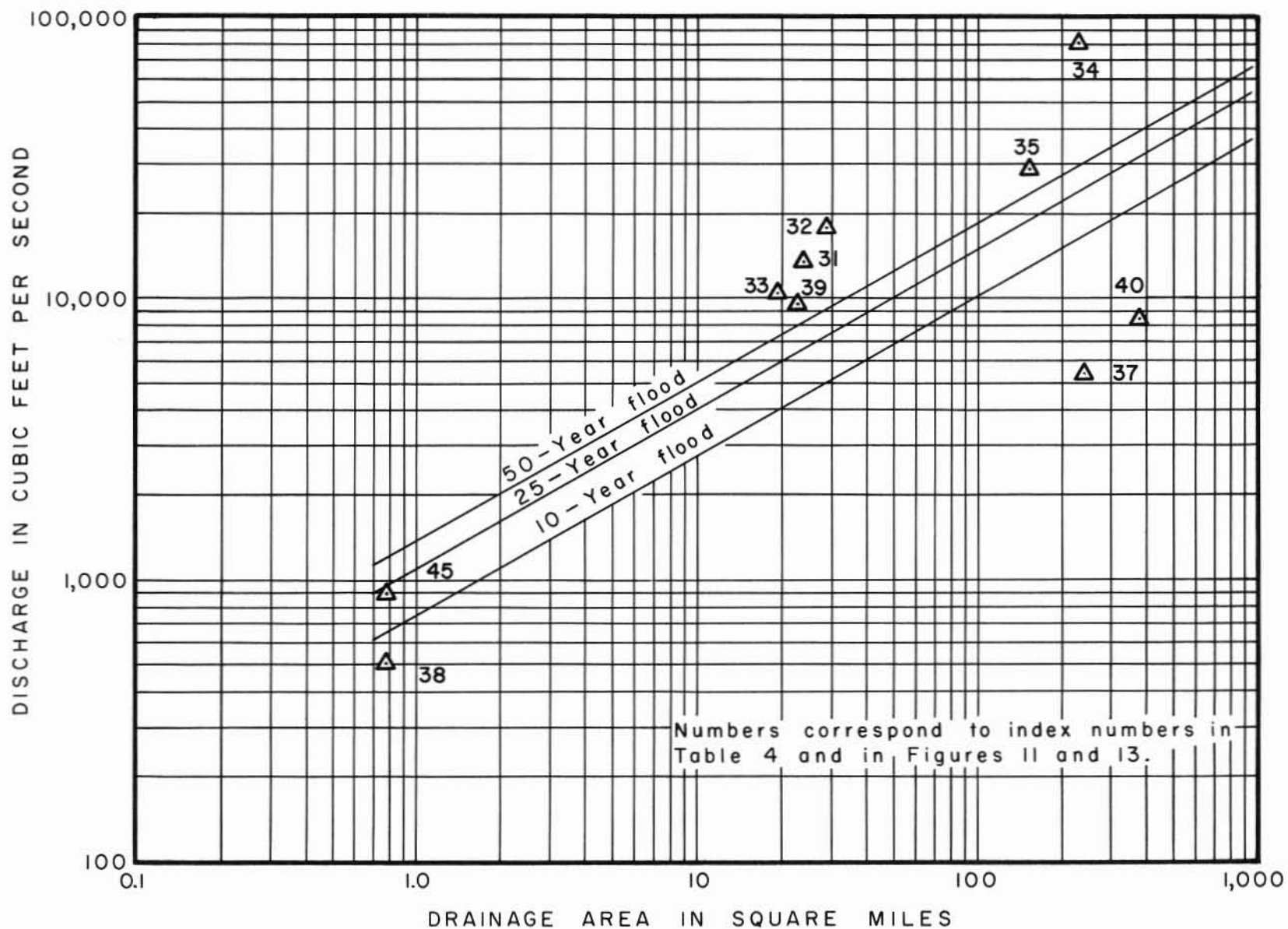


FIG. 15. Relation of peak discharge to drainage area for stations in Grand, Fishing, Crooked, Wakenda, and Osage River basins, for floods of July 18-23, 1965. Frequency curves shown for 10-, 25-, and 50-year floods.

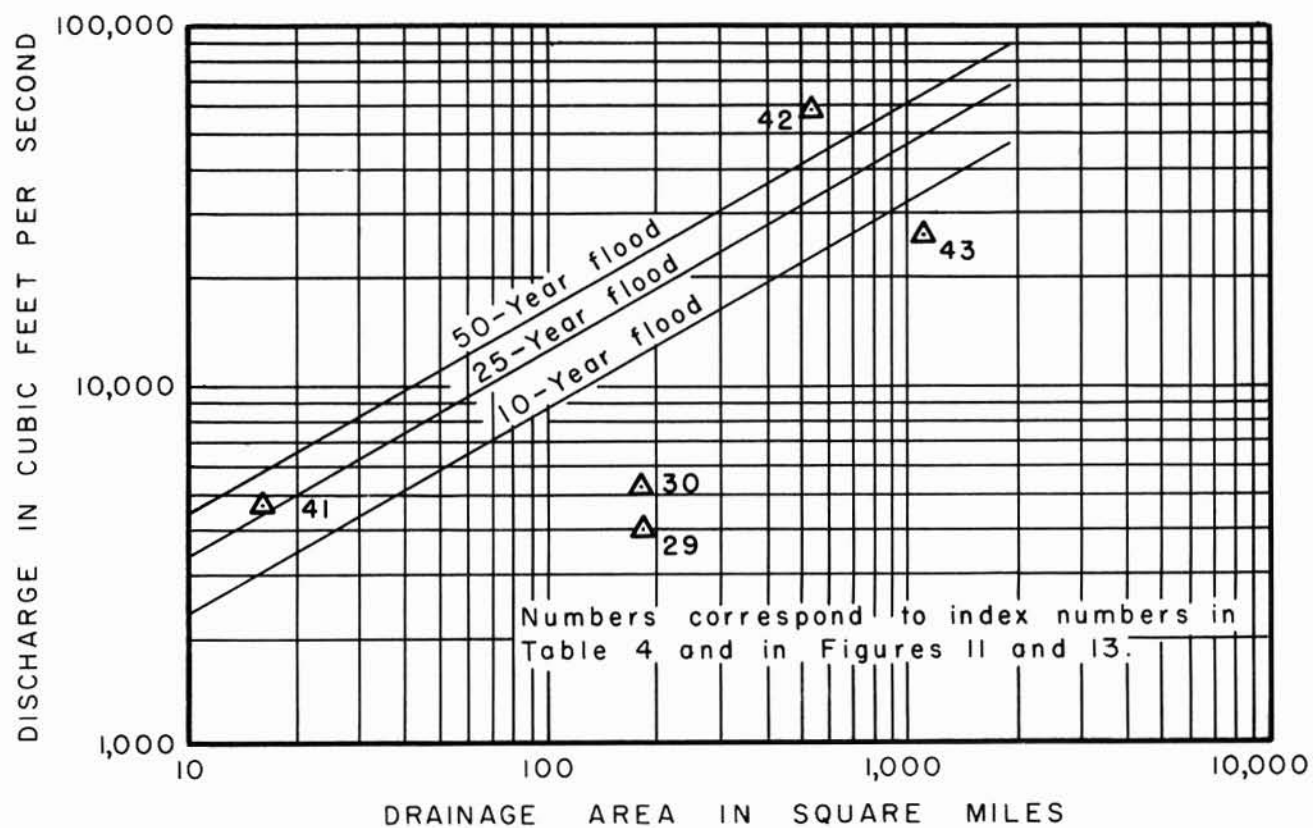


FIG. 16. Relation of peak discharge to drainage area for stations in Blue, Little Blue, and Blackwater River basins, for floods of July 18-23, 1965. Frequency curves shown for 10-, 25-, and 50-year floods.

discharge in excess of the 50-year flood (fig. 16), and the 25-year flood was exceeded at the station on South Fork Blackwater River near Elm.

Comparison with Previous Floods

The floods of July 18-23, 1965 in northwestern Missouri were outstanding in comparison with previous major floods of record. The record floods of June 1947 in the Platte, Little Platte, One Hundred and Two, and Fishing River basins were exceeded in the downstream portions of each of these basins. The floods of July 1951 and September 1961 in the Blue, Little Blue, Fishing, Crooked, Wakenda, and Blackwater River basins were exceeded or approached by the floods of 1965.

The July 1965 flood will long be remembered as "The Big Flood" by those local residents whose houses and crops were damaged or completely destroyed.

STATION DATA

ROCK CREEK BASIN

1 Rock Creek at Rockport

(Miscellaneous site)

Location.--Lat. $40^{\circ}25'00''$ N., long. $95^{\circ}30'40''$ W., in NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 27,

T. 65 N., R. 41 W., at bridge on U. S. Highways 275 and 136 at Rockport.

Drainage Area.--40.1 sq mi.

Discharge record.--Contracted opening measurement at 8,260 cfs.

Maximum.--July 18-23, 1965: Discharge, 8,260 cfs July 18.

2 Boney Branch at Rockport

(Miscellaneous site)

Location.--Lat. $40^{\circ}24'50''$ N., long. $95^{\circ}31'00''$ W., in SW $\frac{1}{4}$ sec. 27, T. 65 N.,

R 41 E., 0.3 mile above mouth in city of Rockport.

Drainage area.--0.76 sq mi.

Discharge record.--Slope-area measurement at 5,080 cfs.

Maximum.--July 18-23, 1965: Discharge 5,080 cfs July 18.

TARKIO RIVER BASIN

3 (6-8130) Tarkio River at Fairfax

Location.--Lat. $40^{\circ}20'20''$ N., long. $95^{\circ}24'20''$ W., in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 22, T. 64 N., R. 40 W., on downstream side of left bridge pier, 0.5 mile west of Fairfax and 2 miles downstream from unnamed creek.

Drainage area.--508 sq mi.

Gage-height record.--Water-stage recorder graph except July 21-23, from graph drawn on basis of once-daily wire-weight gage readings.

Datum of gage is 867.66 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 12,000 cfs.

Maxima.--July 18-23, 1965: Discharge, 9,440 cfs 0530 July 20

(gage height, 19.63 ft).

1922-65: Discharge, 16,300 cfs June 20, 1942; gage height, 22.33 ft July 7, 1929, from floodmark.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 18 1800	6.47	177	July 19 0700	18.40	8,720
1900	6.45	172	0800	18.80	8,840
2000	6.47	177	0900	19.20	8,960
2100	6.98	313	1000	19.40	9,200
2200	8.78	1,100	1100	19.30	8,960
2300	11.48	3,110	1200	19.05	8,720
2400	12.72	4,260	1300	18.40	8,000
July 19 0100	13.60	5,220	1400	17.50	6,800
0200	15.50	7,040	1500	16.70	5,880
0300	15.76	7,280	1600	16.00	5,220
0400	16.20	7,640	1700	15.40	4,560
0500	17.30	8,360	1800	14.80	4,060
0600	18.00	8,600	1900	14.30	3,660

3 (6-8130) Tarkio River at Fairfax

Gage height and discharge at indicated time, 1965--continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 2000	13.90	3,290	July 20 1300	16.00	5,220
2100	13.50	3,110	1400	15.30	4,360
2200	13.10	2,840	1500	14.60	3,860
2300	12.70	2,580	1600	14.00	3,380
2400	13.50	3,110	1700	13.60	3,110
July 20 0100	15.60	4,780	1800	13.20	2,930
0200	18.20	7,760	1900	12.90	2,750
0300	18.70	8,240	2000	12.60	2,580
0400	19.40	9,200	2100	12.40	2,500
0500	19.60	9,440	2200	12.10	2,340
0530	19.63	9,440	2300	11.90	2,260
0600	19.60	9,440	2400	11.60	2,120
0700	19.20	8,960	July 21 0600	10.10	1,500
0800	18.70	8,240	1200	9.10	1,150
0900	18.40	8,000	1800	8.60	940
1000	18.00	7,520	2400	8.24	765
1100	17.50	6,800	July 22 1200	7.64	523
1200	16.80	6,100	2400	7.31	406

4 (6-8135) Missouri River at Rulo, Nebr. (next page)
Mean gage height and discharge, July 1965

Day	gage height (feet)	discharge (cfs)	Day	gage height (feet)	discharge (cfs)
17	9.85	35,900	21	12.69	53,600
18	10.33	38,000	22	12.17	50,800
19	13.33	56,200	23	11.20	45,100
a20	14.99	72,500			

a Peak discharge 85,000 cfs 1030 July 20 (gage height, 16.12 ft).

MISSOURI RIVER MAIN STEM

4 (6-8135) Missouri River at Rulo, Nebr.

Location.--Lat. $40^{\circ}03'15''$ N., long. $95^{\circ}25'15''$ W., in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 17, T. 1 N., R. 18 E., on downstream side of middle pier of bridge on U. S. Highway 159 at Rulo, 3.2 miles upstream from Nemaha River, and at mile 498.0

Drainage area.--418,905 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 837.23 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 85,000 cfs 1030 July 20 (gage height, 16.12 ft).

1881: Gage height, 22.9 ft, from floodmark.

1949-65: Discharge, 358,000 cfs Apr. 22, 1952 (gage height, 25.60 ft).

Remarks.--Flow partly regulated by upstream main stem reservoirs.

LITTLE TARKIO CREEK BASIN

5 (6-8155.5) Staples Branch near Burlington Junction

(Crest-stage station)

Location.--Lat. $40^{\circ}26'15''$ N., long. $95^{\circ}12'05''$ W., in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 17, T. 65 N., R. 38 W., on right bank just upstream from culvert under State Highway 4, about 7.3 miles west of Burlington Junction.

Drainage area.--0.49 sq mi.

Gage-height record.--Crest stages only. Arbitrary datum assigned to gage.

Discharge record.-- Stage-discharge relation defined by current-meter measurements below 3 cfs and by culvert flow measurements at 117 and 371 cfs.

Maxima.--July 18-23, 1965: Discharge, 50 cfs July 19 (gage height 10.94 ft).

1959-65: Discharge, 430 cfs June 21, 1964 (gage height, 15.72 ft).

MILL CREEK BASIN

6 (6-8160) Mill Creek at Oregon

Location.--Lat. 39°58'55" N., long. 95°07'35" W., in NE¼ NE¼ sec. 35,

T. 60 N., R. 38 W., at bridge on U. S. Highway 275, 1 mile southeast of Oregon.

Drainage area.--4.90 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 921.26 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 900 cfs and extended above by logarithmic plotting.

Maxima.--July 18-23, 1965: Discharge, 359 cfs 0845 July 19 (gage height, 3.65 ft).

1951-65: Discharge, 2,730 cfs Sept. 3, 1961 (gage height, 7.10 ft).

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 17 0100	0.92	1.2	July 17 1100	1.08	3.6
0200	0.92	1.2	1200	1.05	3.0
0230	1.10	4.0	1300	1.03	2.7
0300	2.56	102	1400	1.01	2.4
0330	2.13	54	1500	1.00	2.2
0400	2.46	89	1600	0.99	2.1
0500	2.04	46	1700	0.98	2.0
0600	1.67	23	1800	.98	2.0
0700	1.40	12	1900	.97	1.8
0800	1.24	7.1	2000	.97	1.8
0900	1.15	5.0	2100	.97	1.8
1000	1.11	4.2	2200	.97	1.8

6 (6-8160) Mill Creek at Oregon

Gage height and discharge at indicated time, 1965--continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 17 2300	.97	1.8	July 18 2300	1.04	2.8
2400	.97	1.8	2400	1.04	2.8
July 18 0100	.97	1.8	July 19 0100	1.09	3.8
0200	.97	1.8	0200	1.25	7.4
0300	.97	1.8	0300	1.20	6.1
0400	.98	2.0	0400	1.24	7.1
0430	.98	2.0	0500	1.25	7.4
0500	1.18	5.7	0600	1.18	5.7
0530	1.36	11	0700	1.28	8.2
0600	1.54	17	0730	1.80	30
0630	1.42	13	0800	2.04	46
0700	1.56	18	0830	3.50	307
0800	1.46	14	0845	3.65	359
0900	1.37	11	0900	3.59	338
1000	1.86	34	0930	3.05	188
1100	1.66	23	1000	2.44	87
1200	1.64	22	1100	1.97	41
1300	1.39	12	1200	1.72	26
1400	1.23	6.9	1300	1.55	18
1500	1.16	5.3	1400	1.50	16
1600	1.12	4.4	1500	1.90	36
1700	1.09	3.8	1600	2.19	60
1800	1.08	3.6	1700	1.94	39
1900	1.07	3.4	1800	1.68	24
2000	1.05	3.0	1900	1.50	16
2100	1.04	2.8	2000	1.40	12
2200	1.04	2.8	2100	1.34	10

6 (6-8160) Mill Creek at Oregon

Gage height and discharge at indicated time, 1965--continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 2200	1.36	11	July 20 1100	1.43	13
2300	2.18	59	1200	1.39	12
2400	2.05	47	1300	1.35	10
July 20 0100	1.87	34	1400	1.32	9.3
0130	2.45	88	1500	1.29	8.4
0200	2.92	161	1600	1.27	7.9
0300	2.53	98	1700	1.25	7.4
0400	2.43	86	1800	1.23	6.9
0500	2.50	94	1900	1.22	6.6
0600	2.21	62	2000	1.21	6.4
0700	1.92	37	2100	1.21	6.4
0800	1.73	26	2200	1.20	6.1
0900	1.59	19	2300	1.20	6.1
1000	1.50	16	2400	1.19	5.9

NODAWAY RIVER BASIN

7 (6-8175) Nodaway River near Burlington Junction

Location.--Lat. $40^{\circ}26'40''$ N., long. $95^{\circ}05'20''$ W., in NW $\frac{1}{4}$ sec. 17, T. 65 N., R. 37 W., on downstream side of left pier of bridge on State Highway 4, a quarter of a mile upstream from Mill Creek, 0.5 mile downstream from Wabash Railroad Co. bridge, and $1\frac{1}{2}$ miles west of Burlington Junction.

Drainage area.--1,240 sq mi.

Gage-height record.--Water-stage recorder graph except July 18, 22, 23, from graph drawn on basis of once-daily wire-weight gage readings.

Datum of gage is 896.17 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 7,120 cfs 0900 July 19.

(gage height 8.4 ft).

1922-65: Discharge, 32,000 cfs June 14, 1947 (gage height, 19.0 ft); gage height observed, 19.69 ft Mar. 5, 1949, ice jam.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 0100	1.50	334	July 19 1200	7.80	5,980
0200	1.50	334	1300	8.05	6,360
0300	1.50	334	1400	8.20	6,740
0400	3.00	1,200	1500	7.95	6,170
0500	4.80	2,750	1600	7.65	5,600
0600	6.50	4,450	1700	7.25	4,920
0700	7.00	4,920	1800	6.90	4,450
0800	8.10	6,550	1900	6.50	4,000
0900	8.40	7,120	2000	6.20	3,620
1000	8.30	6,930	2100	5.90	3,420
1100	8.05	6,360	2200	5.50	3,130

7 (6-8175) Nodaway River near Burlington Junction

Gage height and discharge at indicated time, 1965--continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 2300	5.20	2,840	July 20 1600	5.30	2,940
2400	4.80	2,480	1800	4.70	2,380
July 20 0200	4.30	2,040	2000	4.32	2,040
0400	3.96	1,740	2200	4.03	1,820
0600	3.94	1,740	2400	3.75	1,570
0800	6.00	3,620	July 21 0600	3.15	1,130
1000	7.20	5,430	1200	2.83	894
1200	6.85	4,920	1800	2.64	761
1400	6.10	3,740	2400	2.52	683

8 Lincoln Creek near Fillmore

(Miscellaneous Site)

Location.--Lat. 39°59'40" N., long. 94°58'25" W., in NW¼ NW¼ sec. 29,
T. 60 N., R. 36 W., at bridge on County Highway H, 2 miles south
of Fillmore.

Drainage area.--20.7 sq mi.

Discharge record.--Contracted opening with flow over road measurement
at 6,170 cfs.

Maximum.--July 18-23, 1965: Discharge, 6,170 cfs July 19.

MISSOURI RIVER MAIN STEM

9 (6-8180) Missouri River at St. Joseph

Location.--Lat. $39^{\circ}58'10''$ N., long. $94^{\circ}51'28''$ W., in sec. 17, T. 57 N.,

R. 35 W., on downstream side of left pier of St. Joseph and Grand

Island Railroad bridge in St. Joseph. River mile, 448.2.

Drainage area.--424,300 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is

788.19 ft above mean sea level, datum of 1929.

Discharge record.--Stage discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 119,000 cfs 0500 July 20

(gage height, 18.22 ft).

1881: Discharge, 370,000 cfs, computed by Corps of Engineers,

Apr. 29 (gage height, 27.2 ft).

June 1844: Discharge, 350,000 cfs, computed by Corps of

Engineers, (gage height 24.5 ft).

1928-65: Discharge, 397,000 cfs Apr. 22, 23, 1952 (gage

height, 26.82 ft).

Remarks.--Flow partly regulated by upstream reservoirs.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 18 0600	10.79	40,900	July 19 2400	16.35	94,000
1200	11.27	44,000	July 20 0200	16.60	97,200
1800	11.62	46,800	0400	17.70	112,000
2400	11.58	46,400	0500	18.22	119,000
July 19 0400	11.48	45,600	0600	18.10	118,000
0800	12.30	52,000	0800	17.70	112,000
1200	14.45	72,000	1000	17.65	111,000
1600	15.40	82,400	1200	17.80	113,000
2000	16.13	91,400	1400	18.00	116,000

9 (6-8180) Missouri River at St. Joseph

Gage height and discharge at indicated time, 1965-- continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 20 1600	18.15	118,000	July 21 1200	15.60	84,800
1800	18.15	118,000	1800	14.80	75,800
2000	18.05	117,000	2400	14.25	70,000
2200	17.90	115,000	July 22 1200	13.31	61,300
2400	17.55	110,000	2400	12.68	55,400
July 21 0600	16.50	96,000			

PLATTE RIVER BASIN

10 (6-8189) Platte River at Ravenwood

Location.--Lat. 40°20'42" N., long. 94°41'10" W., in SE¼ SE¼ sec. 14, T. 64 N., R. 34 W., on downstream side of left pier of bridge on State Highways 4 and 46, three-quarters of a mile west of Ravenwood, and 1 mile downstream from Honey Creek.

Drainage area.--486 sq mi.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 960 ft above mean sea level (from topographic map).

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 680 cfs 1100 July 19 (gage height, 4.21 ft).

1958-65: Discharge, 11,000 cfs Mar. 29, 1960 (gage height, 18.40 ft in gage well, 18.8 ft from outside gage).

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 18 2400	1.97	70	July 19 2200	2.65	192
July 19 0200	1.90	70	2400	2.56	173
0400	2.10	89	July 20 0300	2.82	231
0600	3.30	356	0600	3.38	379
0800	3.80	522	0900	3.75	504
1000	4.18	680	1200	3.55	432
1100	4.21	680	1500	3.15	314
1200	4.15	660	1800	2.83	233
1400	3.88	560	July 20 2100	2.65	192
1600	3.45	400	2400	2.66	194
1800	3.05	288	July 21 1200	2.85	238
2000	2.80	226	2400	2.40	140

11 (6-8195) One Hundred and Two River near Maryville

Location.--Lat. $40^{\circ}23'15''$ N., long. $94^{\circ}49'35''$ W., in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34,

T. 65 N., R. 35 W., on right bank in front of steel-pile pier of county highway bridge, 2 $\frac{1}{2}$ miles northeast of Maryville and 3 $\frac{1}{2}$ miles downstream from Norvey Creek.

Drainage area.--500 sq mi.

Gage-height record.--Water-stage recorder graph except July 18, 21, 23, from graph drawn on basis of once-daily wire-weight gage readings. Datum of gage is 969.90 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 2,520 cfs 1700 July 19 (gage height, 11.20 ft).

1932-65: Discharge, 14,200 cfs June 14, 1947 (gage height, 21.2 ft, from floodmark).

Stage of 21.2 ft occurred at unknown date prior to October 1932, from floodmarks.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 0100	4.30	68	July 19 1000	10.95	2,430
0200	4.30	68	1100	11.12	2,480
0300	4.30	68	1200	11.00	2,430
0400	6.30	540	1300	10.52	2,200
0500	9.05	1,580	1400	10.55	2,250
0600	10.10	2,020	1500	10.88	2,380
0700	10.70	2,300	1600	11.12	2,480
0800	10.87	2,380	1700	11.20	2,520
0900	10.86	2,380	1800	11.06	2,480

11 (6-8195) One Hundred and Two River near Maryville

Gage height and discharge at indicated time, 1965--continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 1900	10.80	2,340	July 20 1200	9.10	1,620
2000	10.42	2,160	1400	8.50	1,380
2100	10.03	1,980	1600	8.05	1,180
2200	9.58	1,820	1800	7.70	1,060
2300	9.25	1,660	2000	7.40	940
2400	8.98	1,580	2200	7.20	870
July 20 0200	8.50	1,380	2400	7.06	818
0400	8.24	1,260	July 21 0600	6.72	600
0600	8.30	1,300	1200	6.23	465
0800	9.00	1,580	1800	5.91	366
1000	9.43	1,740	2400	5.63	296

12 (6-8200) White Cloud Creek near Maryville

Location.--Lat. $40^{\circ}23'22''$ N., long. $94^{\circ}54'33''$ W., in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1, T. 64 N., R. 36 W., at bridge on U. S. Highway 71, 4 miles upstream from Big Slough, and 4.5 miles northwest of Maryville.

Drainage area.--6.06 sq mi.

Gage-height record.--Water-stage recorder graph. Arbitrary datum assigned to gage.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 500 cfs and by contracted opening measurements at 2,250 and 4,100 cfs.

Maxima.--July 18-23, 1965: Discharge, 1,030 cfs 0830 July 19 (gage height, 10.63 ft).

1949-65: Discharge, 4,100 cfs June 1, 1949 (gage height, 13.41 ft).

13 (6-8203) Big Slough near Wilcox

(Crest-stage station)

Location.--Lat. $40^{\circ}23'23''$ N., long. $94^{\circ}55'32''$ W., on south line of SW $\frac{1}{4}$ sec. 35, T. 65 N., R. 36 W., at culvert on U. S. Highway 71, 3 miles southeast of Wilcox.

Drainage area.--1.30 sq mi.

Gage-height record.--Crest stages only. Arbitrary datum assigned to gage.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 125 cfs and by culvert flow measurements at 462, 614, and 1,040 cfs.

Maxima.--July 18-23, 1965: Discharge, 320 cfs July 19 (gage height, 3.33 ft).

1950-65: Discharge, 1,040 cfs June 15, 1964 (gage height, 6.43 ft).

14 (6-8205) Platte River near Agency

Location.--Lat. $39^{\circ}41'20''$ N., long. $94^{\circ}42'15''$ W., in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 10, T. 56 N., R 34 W., near center of left span on upstream side of bridge on U. S. Highway 169, $1\frac{1}{2}$ miles downstream from Third Fork and $3\frac{1}{2}$ miles northeast of Agency.

Drainage area.--1,760 sq mi.

Gage-height record.--Graph drawn on basis of several wire-weight gage readings each day. Datum of gage is 807.38 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Loop rating used from 2200 July 19 to July 24.

Maxima.--July 18-23, 1965: Discharge, 53,000 cfs 1700 July 20 (gage height, 35.05 ft).

1924-30, 1932 to July 18, 1965: Discharge, 50,000 cfs, June 23, 1947; gage height, 30.46 ft June 23, 1947 (loop rating).

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 18 2400	6.00	470	July 19 2400	29.10	42,500
July 19 0200	6.00	470	July 20 0200	30.10	46,200
0400	8.00	1,270	0400	31.00	48,500
0600	15.00	5,850	0600	32.00	50,200
0800	19.20	9,940	0800	33.00	51,500
1000	21.20	13,300	1000	33.60	52,000
1200	22.30	16,000	1200	34.00	52,400
1400	23.10	18,200	1400	34.40	52,700
1600	24.00	21,000	1600	34.80	52,900
1800	25.40	26,100	1700	35.05	53,000
2000	26.50	31,100	1800	35.00	53,000
2200	27.90	37,700	2000	34.90	52,700

14 (6-8205) Platte River near Agency

Gage height and discharge at indicated time, 1965--continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 20 2200	34.80	51,500	July 22 2400	26.70	15,700
2400	34.60	50,400	July 23 0600	25.40	13,000
July 21 0600	34.00	46,700	1200	23.30	10,200
1200	33.00	41,200	1800	19.30	6,900
1800	31.90	35,800	2400	17.70	5,800
2400	31.20	32,500	July 24 0600	16.50	5,100
July 22 0600	30.20	28,000	1200	14.80	4,250
1200	29.30	24,500	1800	12.00	3,000
1800	28.10	20,200	2400	9.70	2,200

15 (6-8210) Jenkins Branch at Gower

Location.--Lat. $39^{\circ}37'29''$ N., long. $94^{\circ}36'01''$ W., in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 34, T. 56 N., R. 33 W., on right bank at upstream side of culvert on U. S. Highway 169, 0.8 mile north of Gower and 4.4 miles upstream from mouth.

Drainage area.--2.72 sq mi.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 905 ft (from topographic map).

Discharge record.--Stage-discharge relation defined by current-meter measurements below 400 cfs and by slope-area measurement at 1,740 cfs and culvert flow measurement at 3,440 cfs.

Maxima.--July 18-23, 1965: Discharge, 3,460 cfs 0020 July 20 (gage height, 13.27 ft).

1950 to July 18, 1965: Discharge, 2,420 cfs June 21, 1964 (gage height, 10.77 ft).

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 18 2400	1.40	0.8	July 19 0600	2.92	114
July 19 2430	1.42	1.0	0630	3.59	223
0100	1.46	1.6	0700	4.16	341
0130	1.52	2.7	0730	3.99	308
0200	1.58	3.8	0800	3.59	223
0230	1.66	5.9	0830	4.00	308
0300	1.71	7.7	0900	4.46	407
0330	1.75	9.4	0930	4.75	474
0400	1.85	14	1000	5.20	584
0430	1.90	16	1030	4.92	510
0500	2.03	25	1100	4.10	330
0530	2.40	55	1130	3.24	161

15 (6-8210) Jenkins Branch at Gower

Gage height and discharge at indicated time, 1965-continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 1200	2.87	107	July 20 0200	5.10	558
1230	2.62	77	0230	4.15	341
1300	2.45	60	0300	3.72	249
1330	2.32	48	0330	3.34	178
1400	2.26	42	0400	3.10	140
1430	2.24	41	0500	2.80	98
1500	2.24	41	0600	2.80	98
1530	2.30	46	0700	2.72	88
1600	2.62	77	0800	2.53	68
1630	2.90	111	0900	2.33	49
1700	3.37	183	1000	2.21	38
1730	3.71	247	1100	2.12	31
1800	3.47	201	1200	2.05	26
1830	3.07	136	1300	2.00	23
1900	2.75	92	1400	1.95	20
1930	2.53	68	1500	1.91	17
2000	2.59	74	1600	1.88	16
2030	6.20	856	1700	1.84	14
2100	7.45	1,200	1800	1.81	12
2130	8.23	1,460	1900	1.79	11
2200	7.25	1,140	2000	1.78	11
2230	6.15	856	2100	1.77	10
2300	5.65	702	2200	1.76	9.9
2330	7.90	1,360	2300	1.76	9.9
2400	10.60	2,340	2400	1.75	9.4
July 20 0020	13.27	3,460	July 21 0600	1.71	6.2
0030	13.10	3,360	1200	1.66	4.8
0100	10.70	2,380	1800	1.63	4.0
0130	7.50	1,230	2400	1.62	3.8

16 Malden Creek near Gower

(Miscellaneous site)

Location.--Lat. $39^{\circ}39'15''$ N., long. $94^{\circ}38'20''$ W., in SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 19, T. 56 N., R. 33 W., at bridge on U. S. Highway 169, 3 miles northwest of Gower.

Drainage area.--9.24 sq mi.

Discharge record.--Contracted opening with flow over road measurement at 12,100 cfs.

Maximum.--July 18-23, 1965: Discharge 12,100 cfs July 20.

17 Mitchell Branch near Edgerton

(Miscellaneous site)

Location.--Lat. $39^{\circ}31'54''$ N., long. $94^{\circ}37'44''$ W., in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 32, T. 55 N., R. 33 W., at culvert on County Highway B, 1.5 miles north of Edgerton.

Drainage area.--1.56 sq mi.

Discharge record.--Culvert flow with flow over road measurement at 3,490 cfs.

Maximum.--July 18-23, 1965: Discharge, 3,490 cfs July 19.

18 Grove Creek Tributary near Edgerton

(Miscellaneous site)

Location.--Lat. $39^{\circ}29'56''$ N., long. $94^{\circ}36'07''$ W., in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 16, T. 54 N., R. 33 W., at culvert on County Highway Z, 1.5 miles southeast of Edgerton.

Drainage area.--1.03 sq mi.

Discharge record.--Culvert flow with flow over road measurement at 2,770 cfs.

Maximum.--July 18-23, 1965: Discharge, 2,770 cfs July 19.

19 Alger Creek at Camden Point

(Miscellaneous site)

Location.--Lat. $39^{\circ}26'57''$ N., long. $94^{\circ}44'00''$ W., in SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 54 N., R. 34 W., at culvert on County Highway E, 0.5 mile southeast of Camden Point.

Drainage area.--2.36 sq mi.

Discharge record.--Culvert flow with flow over road measurement at 3,000 cfs.

Maximum.--July 18-23, 1965: Discharge, 3,000 cfs July 19.

20 Linn Branch Tributary at Grayson

(Miscellaneous site)

Location.--Lat. $39^{\circ}31'52''$ N., long. $94^{\circ}33'51''$ W., in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 55 N., R. 33 W., at culvert on U. S. Highway 169, about 700 feet north of County Highway O, at Grayson.

Drainage area.--0.79 sq mi.

Discharge record.--Culvert flow with flow over road measurement at 2,410 cfs.

Maximum.--July 18-23, 1965: Discharge, 2,410 cfs July 19.

21 Camp Branch at Arley

(Miscellaneous site)

Location.--Lat. $39^{\circ}24'35''$ N., long. $94^{\circ}26'55''$ W., in NW $\frac{1}{4}$ sec. 13, T. 53 N., R. 32 W., at bridge on County Highway C, 0.5 mile north of Arley.

Drainage area.--9.78 sq mi.

Discharge record.--Contracted opening measurement at 5,430 cfs.

Maximum.--July 18-23, 1965: Discharge, 5,430 cfs July 19.

22 (6-8211.5) Little Platte River at Smithville

Location.--Lat. $39^{\circ}23'16''$ N., long. $94^{\circ}35'04''$ W., in NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 22, T. 53 N., R. 33 W., at bridge on U. S. Highway 169 at west edge of Smithville (revised).

Drainage area.--243 sq mi (from Corps of Engineers).

Gage-height record.--Graph drawn on basis of several wire-weight gage readings each day. Datum of gage is 778.18 ft, datum of 1929, levels by Corps of Engineers.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 50,000 cfs and by slope-area measurement at 76,600 cfs. Loop curve used above 30,000 cfs.

Maxima.--July 18-23, 1965: Discharge, 76,600 cfs 0330 July 20

(gage height, 44.8 ft, from floodmark).

1947: Discharge, 26,000 cfs June 22 (gage height, 37.4 ft, from floodmark).

1964 to July 18, 1965: Discharge, 20,000 cfs June 22, 1964 (gage height, 36.4).

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 0200	10.00	100	July 19 2400	39.20	44,000
0400	10.00	100	July 20 0100	41.00	63,000
0600	17.40	820	0200	42.90	71,000
0800	23.00	2,100	0300	44.40	74,000
1000	26.00	2,950	0330	44.80	76,600
1200	28.20	4,400	0400	44.60	74,000
1400	29.50	5,500	0500	43.80	71,000
1600	30.20	6,200	0600	42.90	65,000
1800	31.10	7,200	0700	42.20	62,000
2000	33.90	11,600	0800	41.70	58,000
2200	36.10	19,000	0900	41.10	54,000

22 (6-8211.5) Little Platte River at Smithville

Gage height and discharge at indicated time, 1965--continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 20 1000	40.30	50,000	July 20 2300	34.70	14,000
1100	39.60	43,000	2400	34.40	13,000
1200	39.00	37,000	July 21 0400	33.50	11,500
1300	38.50	33,000	0800	32.50	9,200
1400	38.00	29,000	1200	31.30	7,400
1500	37.50	26,000	1600	30.10	6,100
1600	37.10	24,000	2000	28.80	4,800
1700	36.70	21,500	2400	27.20	3,700
1800	36.30	20,000	July 22 0600	24.30	2,400
1900	35.90	18,000	1200	19.70	1,220
2000	35.60	17,000	1800	17.90	900
2100	35.30	16,000	2400	15.90	620
2200	35.00	15,000			

23 Second Creek at Linkville

(Miscellaneous site)

Location.--Lat. $39^{\circ}18'40''$ N., long. $94^{\circ}38'33''$ W., in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 19,T. 52 N., R. 33 W., at bridge on U. S. Highway 71 By-pass, $\frac{1}{2}$ mile east of Linkville.

Drainage area.--9.99 sq mi.

Discharge record.--Contracted opening with flow over road measurement at 10,000 cfs.

Maximum.--July 18-23, 1965: Discharge, 10,000 cfs July 19.

24 (6-8211.3) First Creek near Nashua

(Crest-stage station)

Location.--Lat. $39^{\circ}17'20''$ N., long. $94^{\circ}35'05''$ W., in NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, T. 52 N., R. 33 W., at culvert on farm road, 150 ft east of U. S. Highway 169 and 1.0 mile south of Nashua.

Drainage area.--0.55 sq mi.

Gage-height record.--Crest stages only. Arbitrary datum assigned to gage.

Discharge record.--Stage-discharge relation defined by current-meter measurement at 15.7 cfs and by culvert flow measurements at 63.7, 258, 310, and 831 cfs.

Maxima.--July 18-23, 1965: Discharge, 831 cfs July 19 (gage height, 18.40 ft, from high-water profile).

1959 to July 18, 1965: Discharge, 310 cfs May 7, 1961 (gage height, 13.25 ft).

25 First Creek near Linkville

(Miscellaneous site)

Location.--Lat. $39^{\circ}18'34''$ N., long. $94^{\circ}36'19''$ W., in NE $\frac{1}{4}$ sec. 21, T. 52 N., R. 33 W., at culvert on U. S. Highway 71 By-pass, 1.5 miles northwest of Nashua, and 2 miles east of Linkville.

Drainage area.--5.23 sq mi.

Discharge record.--Culvert flow measurement at 4,430 cfs.

Maximum.--July 18-23, 1965: Discharge, 4,430 cfs July 19.

26 Little Platte River Tributary near Smithville

(Miscellaneous site)

Location.--Lat. $39^{\circ}24'36''$ N., long. $94^{\circ}36'46''$ W., in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 16,

T. 53 N., R. 33 W., 1500 ft upstream from County Highway KK, 3/4 mile upstream from mouth, and 2 miles northwest of Smithville.

Drainage area.--0.44 sq mi.

Discharge record.-- Flow over dam with slope-area measurement at 1,270 cfs.

Maximum.--July 18-23, 1965: Discharge, 1,270 cfs July 19.

27 Platte River at Platte City

(Miscellaneous site)

Location.--Lat. $39^{\circ}22'39''$ N., long. $94^{\circ}46'50''$ W., in SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 25,

T. 53 N., R. 35 W., at bridge on Interstate Highway 29, 0.5 mile north of Platte City.

Drainage area.-- 2,400 sq mi (from Corps of Engineers).

Discharge record.--Contracted opening at two bridges with flow over road measurement at 114,000 cfs.

Maximum.--July 18-23, 1965: Discharge, 114,000 cfs July 20.

MISSOURI RIVER MAIN STEM

28 (6-8930) Missouri River at Kansas City

Location.--Lat. 39°06'43" N., long. 94°35'16" W., in sec. 32, T. 50 N., R. 33 W., on downstream side of right pier of Chicago, Burlington, & Quincy Railroad bridge at Kansas City, 1.4 miles downstream from Kansas River. River mile, 366.1.

Drainage area.--489,200 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 716.40 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 225,000 cfs 0500 July 21 (gage height, 22.80 ft).

1897-1965: Discharge, 573,000 cfs July 14, 1951; gage height, 36.2 ft July 14, 1951.

1844: Discharge, 625,000 cfs, computed by Corps of Engineers, June 16, 1844 (gage height 38.0 ft).

Remarks.--Flow partly regulated by many reservoirs above station.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 18 1200	10.46	66,900	July 21 0400	22.77	224,000
1800	10.66	68,900	0500	22.80	225,000
2400	11.00	71,400	0800	22.70	222,000
July 19 0600	11.50	74,600	1200	22.55	220,000
1200	12.05	77,400	1600	22.10	214,000
1800	13.15	89,500	2000	21.60	207,000
2400	15.45	119,000	2400	21.00	198,000
July 20 0400	16.80	137,000	July 22 0600	20.10	185,000
0800	18.85	166,000	1200	19.17	172,000
1200	20.00	184,000	1800	18.33	160,000
1600	21.10	199,000	2400	17.45	148,000
2000	22.10	214,000	July 23 1200	15.80	126,000
2400	22.60	222,000	2400	14.45	109,000

BLUE RIVER BASIN

29 (6-8935) Blue River near Kansas City

Location.--Lat. $38^{\circ}57'25''$ N., long. $94^{\circ}33'32''$ W., in SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 28, T. 48 N., R. 33 W., on downstream side of right pier of bridge on County Highway W, 0.4 mile downstream from Indian Creek and 1.7 miles southeast of Kansas City.

Drainage area.-- 188 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 753.73 ft above mean sea level (levels by Corps of Engineers).

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 3,970 cfs 1630 July 20 (gage height, 18.95 ft).

1928: Gage-height about 39 ft Nov. 17, 1928, from information by city of Kansas City.

1939-65: Discharge, 41,000 cfs Sept. 13, 1961 (gage height, 44.46 ft).

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 17 0200	5.39	47	July 17 2000	8.50	625
0400	5.38	46	2200	7.70	425
0600	5.48	58	2400	7.20	328
0800	7.30	347	July 18 0600	6.47	197
1000	10.30	1,140	1200	6.17	148
1200	11.90	1,620	1800	6.03	126
1400	11.40	1,470	2400	5.89	106
1600	11.70	1,560	July 19 0300	5.84	99
1800	10.10	1,080	0600	5.80	93

29 (6-8935) Blue River near Kansas City

Gage height and discharge at indicated time, 1965--continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 0900	5.80	93	July 20 1630	18.95	3,970
1200	6.55	210	1700	18.94	3,970
1500	7.38	366	1800	18.82	3,940
1800	8.57	639	1900	18.60	3,870
2100	7.52	385	2000	18.25	3,720
2400	6.84	263	2100	17.50	3,470
July 20 0100	6.71	236	2200	16.40	3,090
0200	6.60	219	2300	15.10	2,640
0300	6.51	204	2400	13.40	2,100
0400	6.46	195	July 21 0200	10.50	1,230
0500	6.65	228	0400	8.60	667
0600	7.55	395	0600	7.95	493
0700	9.00	765	0800	7.65	425
0800	11.20	1,410	1000	7.45	385
0900	16.70	3,190	1200	7.30	356
1000	18.20	3,720	1400	7.17	328
1100	18.65	3,870	1600	7.03	309
1200	18.84	3,940	1800	6.92	281
1300	18.82	3,940	2000	6.82	263
1400	18.70	3,900	2200	6.74	254
1500	18.78	3,940	2400	6.65	236
1600	18.92	3,970	July 22 1200	6.33	187
			2400	6.15	158

LITTLE BLUE RIVER BASIN

30 (6-8940) Little Blue River near Lake City

Location.--Lat. $39^{\circ}06'00''$ N., long. $94^{\circ}18'00''$ W., in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 35, T. 50 N., R. 31 W., at downstream side of right pier of upstream bridge on dual State Highway 78, 3 miles southwest of Lake City and $10\frac{1}{2}$ miles upstream from mouth.

Drainage area.--184 sq mi.

Gage-height record.--Water-stage recorder. Datum of gage is 719.15 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 5,200 cfs 1130 July 20 (gage height, 25.03 ft).

1948-65: Discharge, 9,460 cfs Sept. 14, 1961 (gage height, 27.94 ft).

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 0200	7.71	70	July 20 1130	25.03	5,200
0400	7.95	85	1200	25.02	5,200
0600	9.40	205	1800	24.90	5,100
0800	12.10	523	2400	24.60	4,800
1000	15.80	1,050	July 21 0600	24.15	4,430
1200	18.50	1,620	1200	23.40	3,780
1400	20.30	2,160	1800	21.85	2,840
1600	20.90	2,400	2400	18.75	1,690
1800	21.60	2,740	July 22 0600	15.20	959
2000	23.40	3,780	1200	12.20	536
2200	24.60	4,800	1800	10.70	345
2400	24.92	5,100	2400	10.25	288
July 20 0600	24.98	5,200			

FISHING RIVER BASIN

31 Fishing River near Roosterville

(Miscellaneous site)

Location.--Lat. $39^{\circ}19'45''$ N., long. $94^{\circ}25'00''$ W., on line between secs. 7 and 8, T. 52 N., R. 31 W., at bridge on county road, 1 mile east of County Highway C and $2\frac{1}{2}$ miles northeast of Roosterville.

Drainage area.--24.7 sq mi.

Discharge record.--Contracted opening with flow over road measurement at 13,500 cfs.

Maximum.--July 18-23, 1965: Discharge, 13,500 cfs July 19.

32 Clear Creek near Kearney

(Miscellaneous site)

Location.--Lat. $39^{\circ}23'40''$ N., long. $94^{\circ}22'15''$ W. on line between NE $\frac{1}{4}$ and NW $\frac{1}{4}$ sec. 22, T. 53 N., R. 31 W., at bridge on State Highway 33, 1.9 miles north of junction of State Highways 33 and 92 in Kearney.

Drainage area.--29.4 sq mi.

Discharge record.--Contracted opening measurement at 17,900 cfs.

Maximum.--July 18-23, 1965: Discharge, 17,900 cfs July 19.

33 (6-8945) East Fork Fishing River at Excelsior Springs

Location.--Lat. $39^{\circ}20'20''$ N., long. $94^{\circ}12'45''$ W., in SE $\frac{1}{4}$ sec. 1, T. 52 N., R. 30 W., on downstream side of right abutment of Golf Hill Bridge in Excelsior Springs, three-quarters of a mile upstream from Dry Fork Fishing River and 6 $\frac{3}{4}$ miles upstream from mouth.

Drainage area.--20.0 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 759.46 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 5,000 cfs and by contracted opening measurements at 10,500 cfs and 12,000 cfs.

Maxima.--July 18-23, 1965: Discharge, 10,500 cfs 2145 July 19 (gage height, 16.05 ft).

1951 to July 18, 1965: Discharge, 12,000 cfs July 6, 1951 (gage height, 15.3 ft).

Floods of June 22, 1947, July 6, 1951, and July 19, 1965 reached stages of 23.7, 20.0, and 19.7 ft, respectively, at a point 200 ft upstream, on right bank.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 0100	3.63	10	July 19 1000	11.10	4,760
0200	3.60	9	1100	12.20	5,920
0300	3.58	8	1200	12.10	5,810
0400	3.80	20	1300	11.15	4,860
0500	4.45	81	1400	10.00	3,650
0600	7.10	1,100	1500	8.40	2,160
0700	8.55	2,340	1600	7.75	1,620
0800	9.60	3,270	1700	7.35	1,300
0900	10.45	4,050	1800	9.50	3,180

33 (6-8945) East Fork Fishing River at Excelsior Springs

Gage height and discharge at indicated time, 1965--continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 1900	11.90	5,600	July 20 1400	7.12	364
2000	14.20	8,160	1500	6.95	298
2100	14.10	8,040	1600	6.85	264
2145	16.05	10,500	1700	6.75	232
2200	15.70	10,000	1800	6.65	204
2300	14.00	7,850	1900	6.57	188
2400	12.55	6,100	2000	6.51	168
July 20 0100	11.70	4,980	2100	6.45	154
0200	10.65	3,620	2200	6.40	142
0300	9.70	2,570	2300	6.35	132
0400	9.50	2,350	2400	6.32	126
0500	9.90	2,790	July 21 0600	6.13	75
0600	10.15	3,140	1200	5.97	67
0700	9.75	2,620	1800	5.82	47
0800	9.25	2,080	2400	5.73	39
0900	8.60	1,410	July 22 1200	5.60	27
1000	8.10	980	2400	5.48	18
1100	7.75	720	July 23 1200	5.43	14
1200	7.50	560	2400	5.37	10
1300	7.30	450			

34 Fishing River at Milondale

(Miscellaneous site)

Location.--Lat. $39^{\circ}16'00''$ N., long. $94^{\circ}13'19''$ W., in SW $\frac{1}{4}$ sec. 36, T.

52 N., R. 30 W., at bridge on County Highway N, 0.5 mile north of Milondale and 4 miles south of Excelsior Springs.

Drainage area.--238 sq mi. (from Corps of Engineers).

Discharge record.--Contracted opening at two bridges with flow over road measurement at 80,200 cfs.

Maxima.--July 18-23, 1965: Discharge, 80,200 cfs July 20.

1947: Discharge, 32,000 cfs June 22. (Slope-area measurement by Corps of Engineers.)

CROOKED RIVER BASIN

35 (6-8950) Crooked River near Richmond

Location.-- Lat. $39^{\circ}20'$ N., long. $93^{\circ}59'$ W., in NW $\frac{1}{4}$ sec. 7, T. 52 N.,

R. 27 W., on downstream side of third pier from left end of bridge on State Highway 13, 4 miles north of Richmond, $8\frac{1}{2}$ miles upstream from West Fork Crooked River and $24\frac{1}{2}$ miles upstream from mouth.

Drainage area.--159 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 706.34 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 29,000 cfs 0200 July 20

(gage height, 30.70 ft).

1948 to July 18, 1965: Discharge, 27,000 cfs July 6, 1951

(gage height, 28.8 ft, from floodmark).

35 (6-8950) Crooked River near Richmond

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 0400	6.26	26	July 20 1200	29.00	16,200
0500	6.32	29	1400	28.75	15,000
0600	7.00	72	1600	28.50	13,800
0700	8.90	253	1800	28.27	12,600
0800	13.70	952	2000	28.05	11,400
0900	17.40	1,650	2200	27.87	10,900
1000	20.00	2,370	2400	27.64	10,000
1100	21.50	2,980	July 21 0200	27.40	9,300
1200	23.00	3,690	0400	27.16	8,700
1300	24.00	4,420	0600	26.92	8,100
1400	24.60	5,030	0800	26.65	7,500
1500	25.10	5,530	1000	26.29	6,930
1600	25.40	5,940	1200	25.95	6,410
1700	25.60	6,250	1400	25.50	5,800
1800	25.85	6,750	1600	25.00	5,150
1900	26.20	7,110	1800	24.40	4,510
2000	26.60	7,900	2000	23.65	3,910
2100	27.10	9,000	2200	22.75	3,350
2200	28.20	13,200	2400	21.60	2,840
2300	29.50	20,400	July 22 0200	19.95	2,230
2400	30.15	25,000	0400	17.90	1,690
July 20 0200	30.70	29,000	0600	15.60	1,220
0400	30.25	25,800	0800	13.70	904
0600	29.80	21,800	1000	12.00	600
0800	29.60	20,400	1200	10.50	428
1000	29.25	18,300	1400	9.50	291

35 (6-8950) Crooked River near Richmond

Gage height and discharge at indicated time, 1965-continued

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 22 1600	8.92	217	July 23 0600	8.09	150
1800	8.66	190	1200	7.92	128
2000	8.50	175	1800	7.75	114
2200	8.40	170	2400	7.58	102
2400	8.30	160			

MISSOURI RIVER MAIN STEM

36 (6-8955) Missouri River at Waverly

Location.--Lat. $39^{\circ}12'51''$ N., long. $93^{\circ}30'57''$ W., in sec. 14, T. 51 N., R. 24 W., on downstream side of second pier from right bank of bridge on U. S. Highway 65 at Waverly. River mile, 293.4.

Drainage area.--491,200 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 646.00 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 276,000 cfs 0100 July 22 (gage height, 26.80 ft).

1929-65: Discharge, 549,000 cfs July 16, 1951; gage height, 28.20 ft July 14, 1951.

Remarks.--Flow partly regulated by many reservoirs above station.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 18 2400	14.12	69,000	July 21 2400	26.75	275,000
July 19 0600	14.20	71,000	July 22 0100	26.80	276,000
1200	15.30	83,400	0300	26.75	271,000
1800	16.90	105,000	0600	26.65	260,000
2400	18.60	127,000	0900	26.45	251,000
July 20 0600	20.30	152,000	1200	26.15	240,000
1200	21.80	180,000	1500	25.85	229,000
1800	23.60	216,000	1800	25.45	217,000
2400	25.20	247,000	2100	25.05	205,000
July 21 0300	25.70	256,000	2400	24.35	189,000
0600	26.10	263,000	July 23 0600	23.20	168,000
0900	26.35	268,000	1200	22.10	152,000
1200	26.45	270,000	1800	21.10	139,000
1500	26.50	270,000	2400	20.10	127,000
1800	26.45	270,000	July 24 1200	18.70	111,000
2100	26.55	271,000	2400	17.40	96,900

WAKENDA CREEK BASIN

37 (6-8960) Wakenda Creek at Carrollton

Location.--Lat. $39^{\circ}21'$ N., long. $93^{\circ}30'$ W., in NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 5, T. 52 N., R. 23 W., on left bank near upstream side of bridge on U. S. Highway 65 in Carrollton, half a mile downstream from Brush Creek and 14 miles upstream from mouth.

Drainage area.--248 sq mi.

Gage height record.--Water-stage recorder graph. Datum of gage is 641.17 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 5,500 cfs 0400 July 21 (gage height, 22.90 ft).

1948-65: Discharge, 7,000 cfs Mar. 20, 1948 and July 2, 1960; gage height, 23.4 ft July 17, 1951, from graph based on gage readings (backwater and overflow from Missouri River); gage height (no backwater), 23.07 ft Sept. 14, 1961.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 19 0200	5.50	20	July 20 1200	21.60	4,090
0400	5.50	20	1600	22.15	4,700
0600	6.00	43	2000	22.50	5,020
0800	8.00	202	2400	22.78	5,340
1000	10.30	476	July 21 0400	22.90	5,500
1200	13.00	900	0800	22.82	5,180
1400	16.90	1,860	1200	22.50	4,420
1600	18.80	2,540	1600	21.80	3,730
1800	19.65	2,920	2000	20.80	2,970
2000	20.00	3,130	2400	19.40	2,180
2200	20.20	3,250	July 22 0600	16.75	1,290
2400	20.35	3,370	1200	14.30	704
July 20 0400	20.65	3,490	1800	12.55	448
0800	21.05	3,730	2400	11.40	346

SELECTED STATIONS IN GRAND RIVER BASIN

38 (6-8967) O'Neill Branch at Osborn

(Crest-stage station)

Location.--Lat. $39^{\circ}45'25''$ N., long. $94^{\circ}20'35''$ W., in SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 14, T. 57 N., R. 31 W., on left bank just upstream from culvert under U. S. Highway 36, 1 mile northeast of Osborn and 5.5 miles northwest of Cameron.

Drainage area.--0.80 sq mi.

Gage-height record.--Crest stages only. Arbitrary datum assigned to gage.

Discharge record.--Stage-discharge relation defined by culvert flow measurements at 146, 239, 427, and 1,320 cfs.

Maxima.--July 18-23, 1965: Discharge, 510 cfs July 19 (gage height, 18.28 ft).

1955-65: Discharge, 1,320 cfs July 30, 1958 (gage height, 24.20 ft).

39 Shoal Creek near Turney

(Miscellaneous site)

Location.--Lat. $39^{\circ}38'15''$ N., long. $94^{\circ}16'50''$ W., in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 28, T. 56 N., R. 30 W., at bridge on County Highway H, 2.0 miles east of Turney.

Drainage area.--23.3 sq mi.

Discharge record.--Contracted opening with culvert flow and flow over road measurement at 9,640 cfs.

Maximum.--July 18-23, 1965: Discharge, 9,640 cfs July 19.

40 (6-8997) Shoal Creek near Braymer

Location.--Lat. $39^{\circ}40'05''$ N., long. $93^{\circ}46'05''$ W., in NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 13, T. 56 N., R. 26 W., at downstream side of left pier of bridge on Caldwell County Road 0, 1 $\frac{3}{4}$ miles downstream from Panther Creek, and 6 miles north of Braymer.

Drainage area.--391 sq mi.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 700 ft (from topographic map).

Discharge record.--Defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 8,600 cfs 0100 July 22 (gage height, 26.0 ft).

1957-65: Discharge, 26,000 cfs June 22, 1964; gage height, 29.05 ft June 22, 1964.

Mean gage height and discharge, July 1965

Day	gage height (feet)	discharge (cfs)	Day	gage height (feet)	discharge (cfs)
18	3.17	29	^a 22	25.46	7,900
19	9.02	408	23	20.31	4,480
20	18.91	3,460	24	6.85	325
21	23.32	6,200	25	5.55	175

a Peak discharge, 8,600 cfs 0100 July 22 (gage height, 26.0 ft).

SELECTED STATIONS IN LAMINE RIVER BASIN

41 (6-9075) South Fork Blackwater River near Elm

Location.--Lat. $38^{\circ}49'05''$ N., long. $94^{\circ}02'05''$ W., in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 5, T. 46 N., R. 28 W., on left bank at downstream side of bridge on county highway, $2\frac{1}{2}$ miles southeast of Elm and 3 miles upstream from mouth.

Drainage area.--16.4 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is about 795 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 600 cfs and by contracted opening with flow over road measurement at 5,600 cfs.

Maxima.--July 18-23, 1965: Discharge, 4,610 cfs 2245 July 19 (gage height, 11.12 ft).

1951: July flood reached a stage of 14.8 ft, from information by local residents.

1954-65: Discharge, 5,600 cfs Apr. 15, 1960 (gage height, 12.0 ft).

Remarks.--Runoff affected at times by many soil conservation ponds upstream.

43 (6-9080) Blackwater River at Blue Lick

Location.--Lat. $38^{\circ}59'30''$ N., long. $93^{\circ}12'15''$ W., on line between secs.

27 and 34, T. 49 N., R. 21 W., on right bank, 25 ft upstream from bridge on U. S. Highway 65, three-quarters of a mile downstream from Finley Creek and 1 mile south of Blue Lick.

Drainage area.--1,120 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 593.79 ft above mean sea level, datum of 1929.

Discharge record.--Stage discharge relation defined by current-meter measurements below 32,000 cfs and extended above by logarithmic plotting.

Maxima.--July 18-23, 1965: Discharge, 26,000 cfs 0800 July 23

(gage height, 37.50 ft).

1922-33, 1938-65: Discharge, 54,000 cfs Nov. 18, 1928

(gage height, 41.25 ft, from floodmark).

Mean gage height and discharge, July 1965

Day	gage height (feet)	discharge (cfs)	Day	gage height (feet)	discharge (cfs)
18	11.03	564	24	36.15	21,400
19	19.28	2,760	25	34.00	15,400
20	28.45	7,270	26	31.68	11,800
21	32.50	14,700	27	29.28	8,130
22	36.80	24,100	28	25.80	5,360
a 23	37.35	25,500			

a Peak discharge, 26,000 cfs 0800 July 23 (gage height, 37.50 ft).

MISSOURI RIVER MAIN STEM

44 (6-9090) Missouri River at Boonville

Location.--Lat. $38^{\circ}58'40''$ N., long. $92^{\circ}45'15''$ W., in sec. 35, T. 49 N., R. 17 W., on downstream side of second pier from right abutment of Missouri-Kansas-Texas Co. bridge at Boonville. River mile, 196.6.

Drainage area.--505,700 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 565.42 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-23, 1965: Discharge, 253,000 cfs 1300 July 23 (gage height, 26.05 ft).

1844: Flood of June 21 reached a stage of 32.7 ft (discharge, about 710,000 cfs, computed by Corps of Engineers).

1903: Flood of June 6 reached a stage of 30.5 ft (discharge, about 612,000 cfs, computed by Corps of Engineers).

1925-65: Discharge, 550,000 cfs July 17, 1951; gage height, 32.82 ft July 17, 1951.

Remarks.--Flow partly regulated by many reservoirs above station.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 18 2400	12.97	71,800	July 23 1300	26.05	253,000
July 19 1200	13.44	76,300	1800	25.85	250,000
1800	13.92	80,500	2400	25.62	246,000
2400	15.15	93,400	July 24 1200	24.37	222,000
July 20 1200	18.45	134,000	2400	22.37	191,000
2400	21.48	176,000	July 25 1200	20.35	158,000
July 21 1200	23.56	211,000	2400	18.70	136,000
2400	24.56	227,000	July 26 1200	17.33	116,000
July 22 1200	25.25	241,000	2400	16.38	105,000
2400	25.85	251,000	July 27 1200	15.35	94,000
July 23 0600	26.00	252,000	2400	14.55	85,500
1200	26.03	253,000			

SELECTED STATIONS IN OSAGE RIVER BASIN

45 (6-9217) West Branch Crawford Creek near Lees Summit

(Crest-stage station)

Location.--Lat. $38^{\circ}52'48''$ N., long. $94^{\circ}12'52''$ W., in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 15, T. 47 N., R. 30 W., at culvert under U. S. Highway 50, 0.2 mile east of junction of highways 50 and 20 E, 1.2 miles east of Cockrell, and about 8.5 miles southeast of Lees Summit.

Drainage area.--0.80 sq mi.

Gage-height record.--Crest stages only. Arbitrary datum assigned to gage.

Discharge record.--Stage-discharge relation defined by culvert flow measurements at 221, 345, and 839 cfs.

Maxima.--July 18-23, 1965: Discharge, 900 cfs July 19 (gage height, 15.73 ft).

1955 to July 18, 1965: Discharge, 839 cfs April 6, 1960 (gage height, 15.57 ft).

46 (6-9345) Missouri River at Hermann

Location.--Lat. $38^{\circ}42'36''$ N., long. $91^{\circ}26'21''$ W., in SW $\frac{1}{4}$ sec. 25, T.

46 N., R. 5 W., on downstream side of third pier from right abutment of bridge on State Highway 19 at Hermann. River mile, 97.9.

Drainage area.--528,200 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 481.56 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--July 18-24, 1965: Discharge, 256,000 cfs 1600 July 24

(gage height, 25.40 ft).

1844: June flood reached stage of 35.5 ft (discharge, about 892,000 cfs, computed by Corps of Engineers).

1897-1965: Discharge, 676,000 cfs June 6, 7, 1903; gage height, 33.33 ft July 19, 1951.

Remarks.--Flow partly regulated by many reservoirs above station.

Gage height and discharge at indicated time, 1965

Time	Gage height (feet)	Discharge (cfs)	Time	Gage height (feet)	Discharge (cfs)
July 20 0600	13.00	80,000	July 24 1600	25.40	256,000
1200	13.90	89,000	2400	25.20	253,000
2400	16.80	123,000	July 25 1200	24.60	242,000
July 21 1200	20.00	168,000	2400	23.00	214,000
2400	22.40	206,000	July 26 1200	20.90	179,000
July 22 1200	23.55	225,000	2400	18.90	148,000
2400	23.90	231,000	July 27 1200	17.20	124,000
July 23 1200	24.50	241,000	2400	16.10	110,000
2400	24.95	248,000	July 28 1200	15.15	100,000
July 24 1200	25.35	255,000	2400	14.60	94,000

REFERENCES

- Corbett, D. M., and others, 1943, Stream-gaging procedure: U. S. Geol. Survey Water-Supply Paper 888, 245 pp., 14 figs., 33 pls.
- Hershfield, D. M., 1961, Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years: U. S. Weather Bureau Tech. Paper No. 40, 61 pp., 15 figs., 54 charts.
- Jennings, A. H., Jan. 1950, World's greatest observed point rainfalls: U. S. Weather Bureau Monthly Weather Review, pp. 4-5, table 1, fig. 1.
- Riedel, J. T., Appleby, J. F., and Schloemer, R. W., 1956, Seasonal variation of the probable maximum precipitation east of the 105th meridian for areas from 10 to 1,000 square miles and durations of 6, 12, 24, and 48 hours: U. S. Weather Bureau and Corps of Engineers Hydrometeorological Report No. 33, 58 pp., 26 figs.